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Nanomaterial-based sensing of phenolic compounds and related antioxidant capacity in food

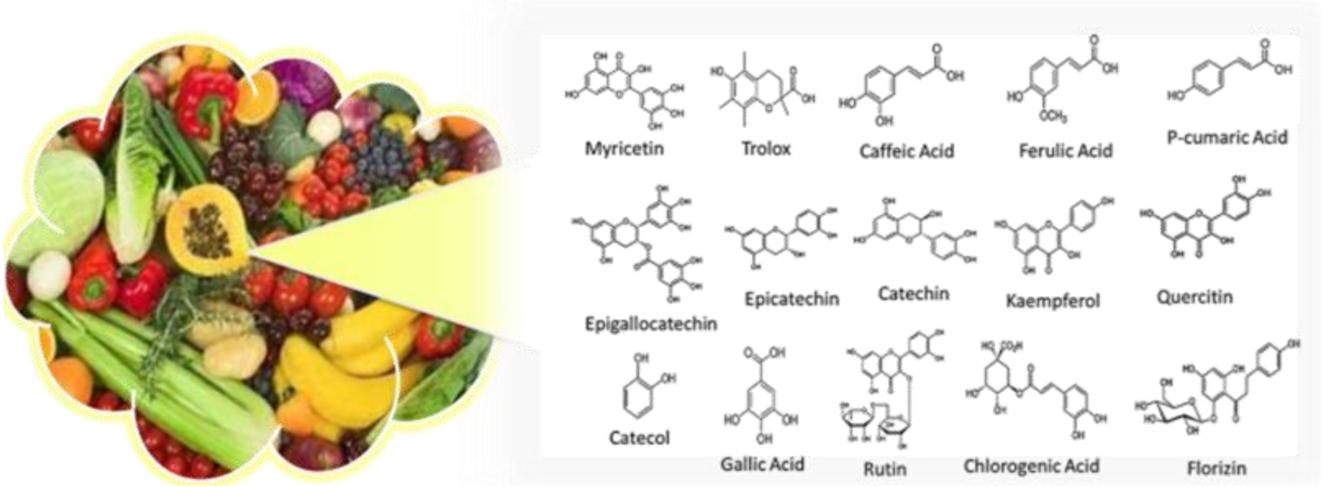
Dario Compagnone

Faculty of Biosciences for Food Agriculture and Environment

University of Teramo

Polyphenol compounds

Heterogeneous class of chemical compounds of considerable interest in the food industry:



http://phenol-explorer.eu


Nutritional property / functional food


Sensory characteristics definition (bitterness, astringency, etc...)


key role in shelf-life


Indicators of quality


Process indicators


Anti-microbial property

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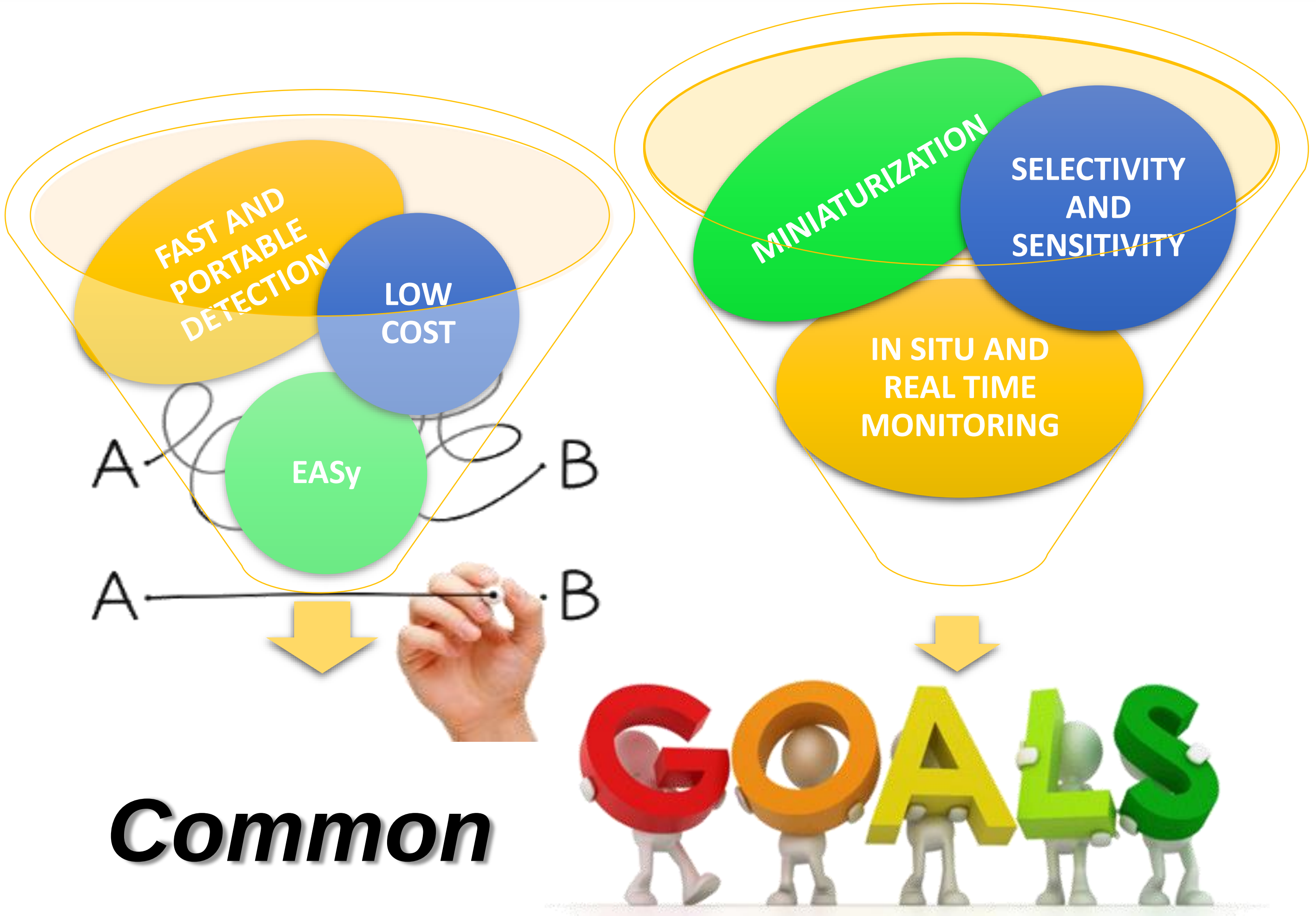
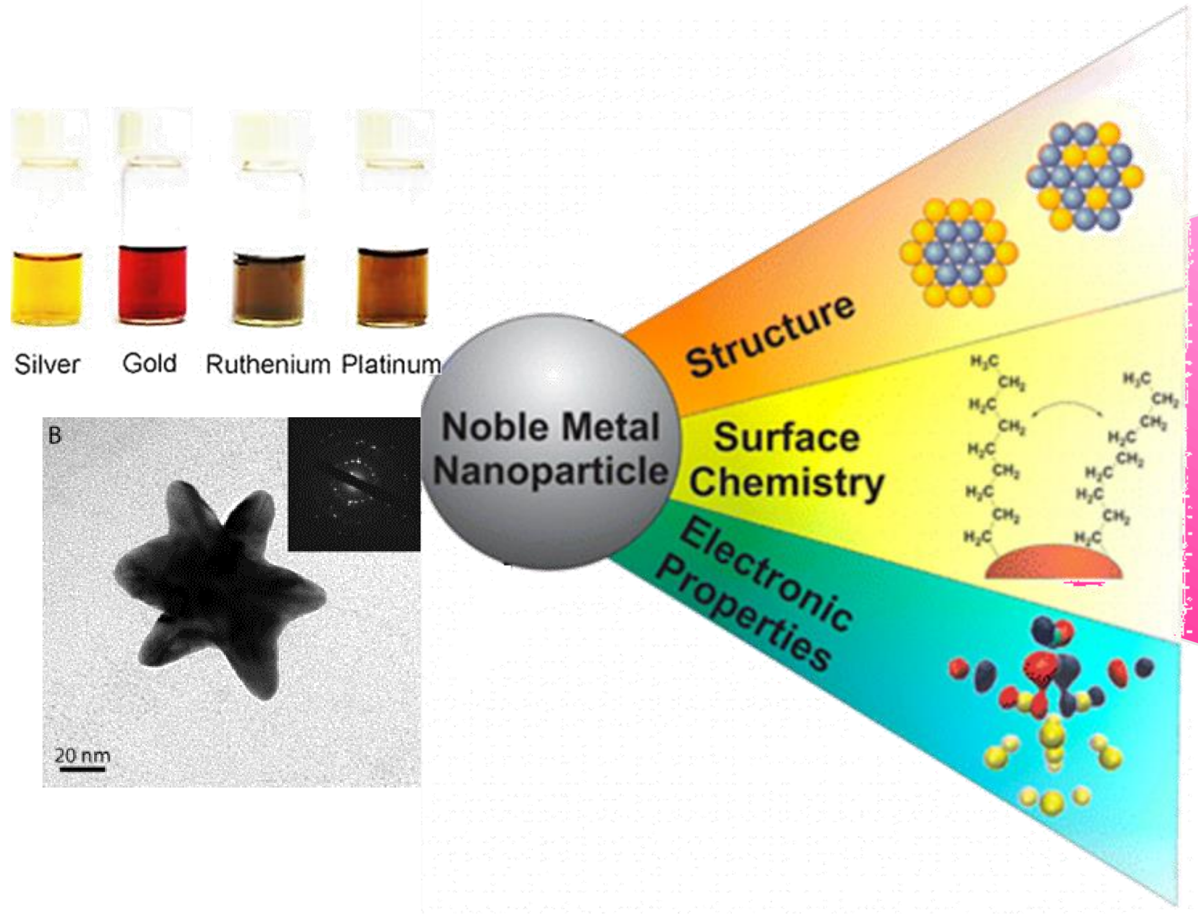
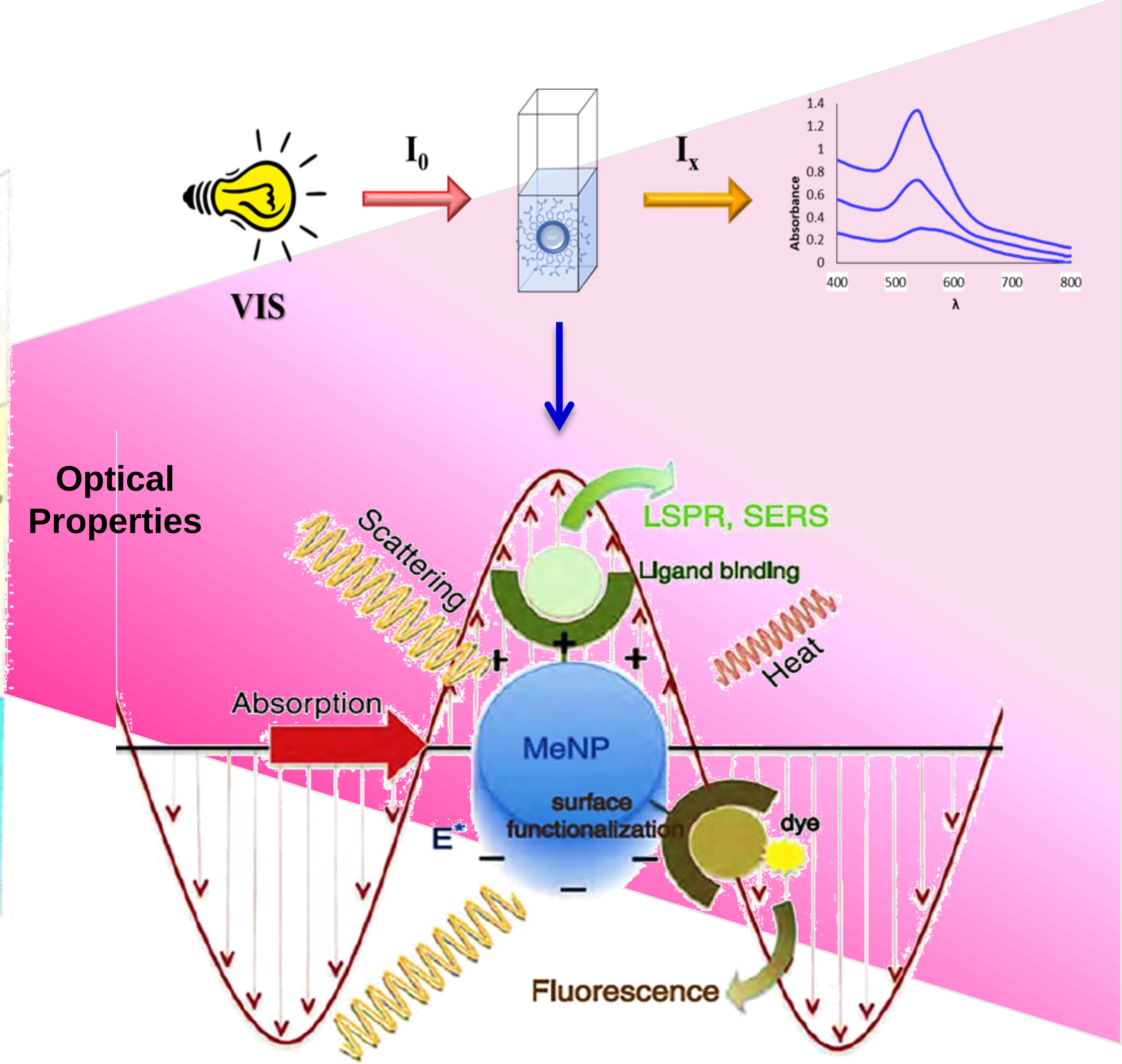
Nanomaterial-based methodologies for sensing of phenolic compounds and their antioxidant capacity in food



Metal nanoparticles (MNPs)

MNPs features

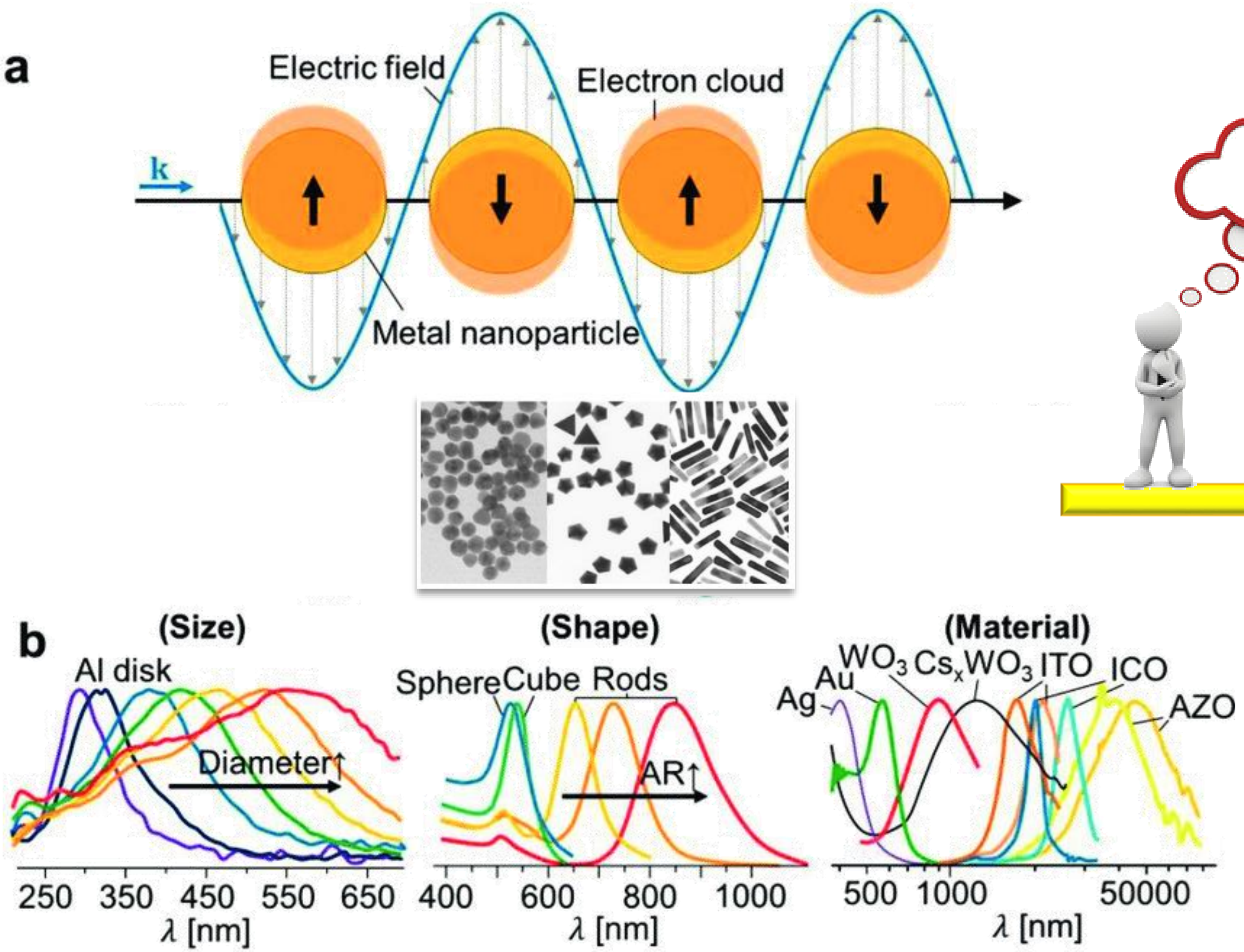


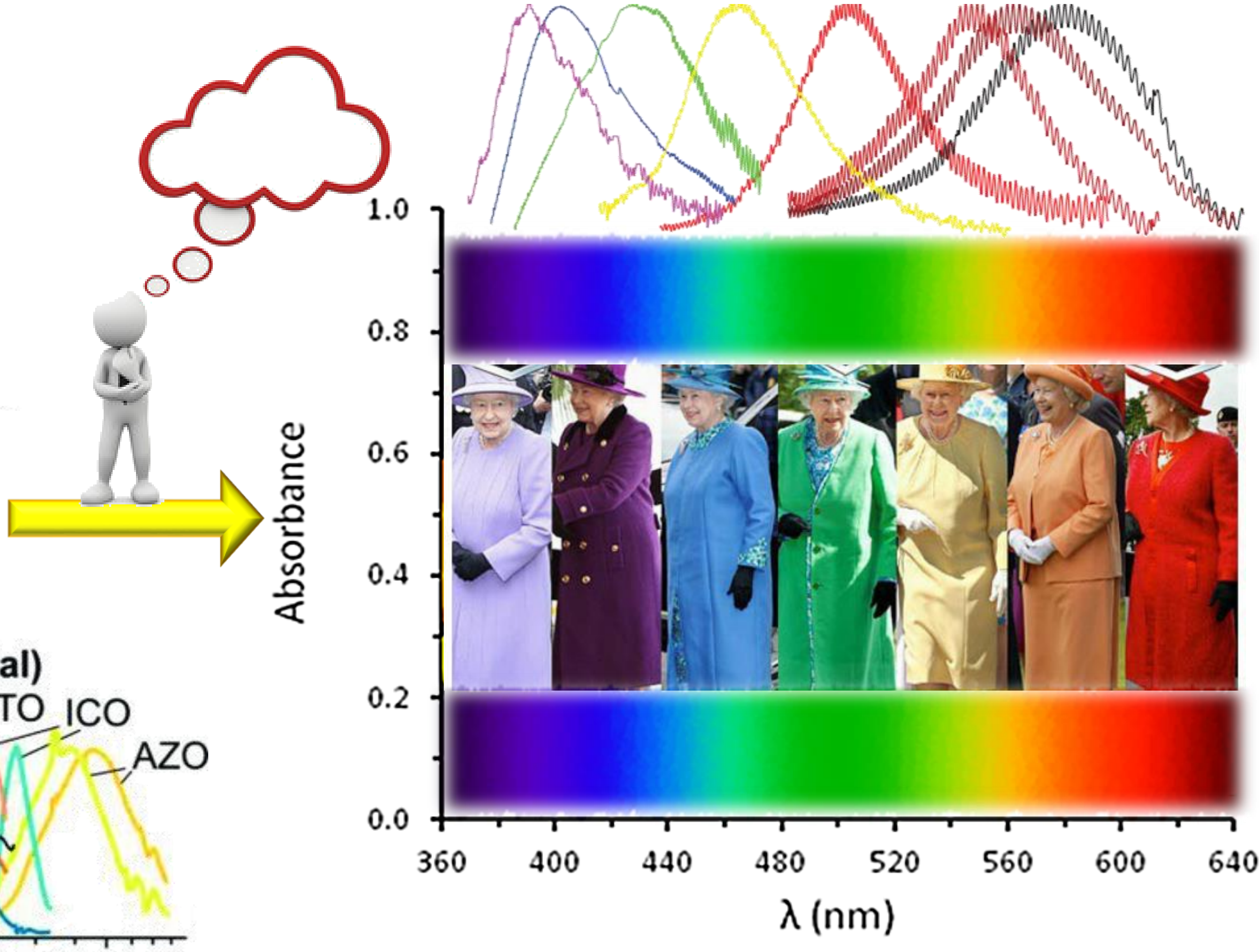


http://nanotechweb.org/cws/article/lab/62061
http://offpistechem.blogspot.com/2015/04/nmr-techniques-for-noble-metal.html

Metal nanoparticles (MNPs)

Analytical principle → *Localized Surface Plasmon Resonance (LSPR)*

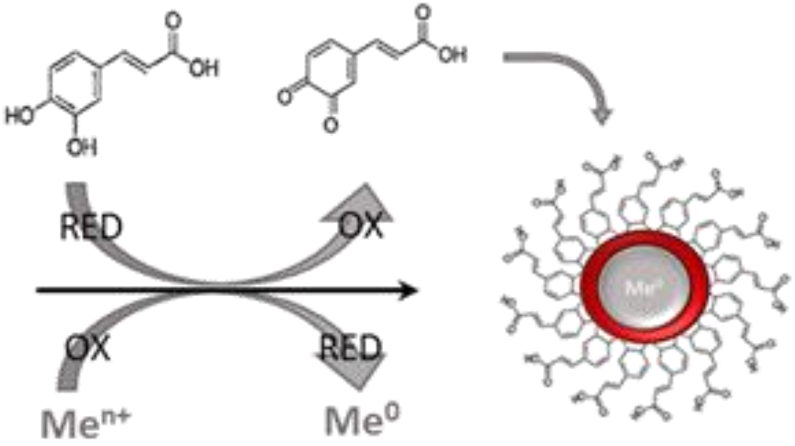


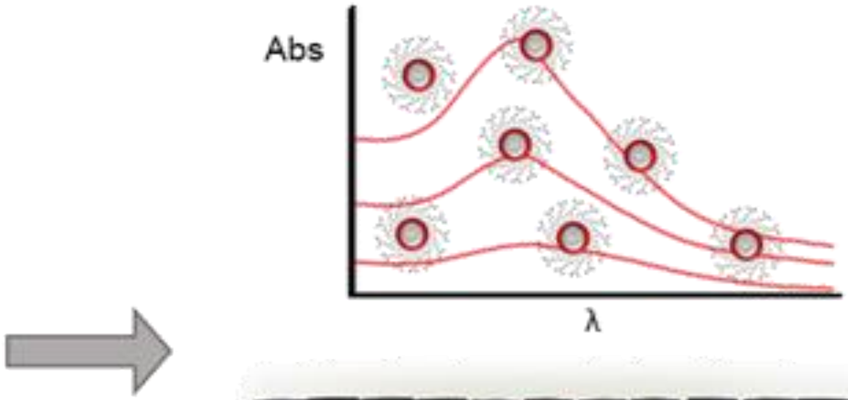


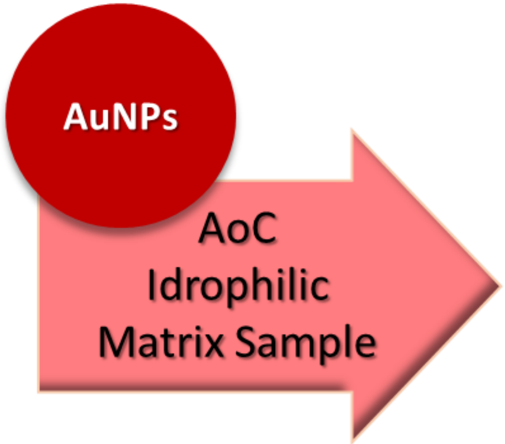
GÉRARD, Davy; GRAY, Stephen K. Aluminium plasmonics. *Journal of Physics D: Applied Physics*, 2014, 48.18: 184001.
CHEN, Huanjun, et al. Shape-and size-dependent refractive index sensitivity of gold nanoparticles. *Langmuir*, 2008, 24.10: 5233-5237.
LOUNIS, Sebastien D., et al. Defect chemistry and plasmon physics of colloidal metal oxide nanocrystals. *The journal of physical chemistry letters*, 2014, 5.9: 1564-1574.

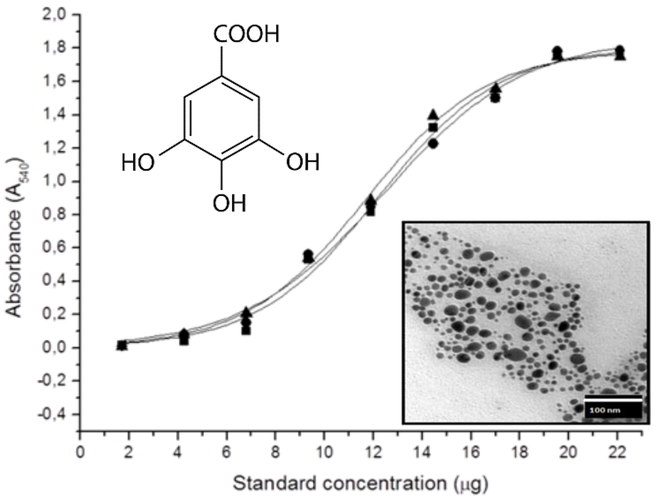
General strategy

Metal nanoparticles suspensions (MNPs) can be produced by reducing agents





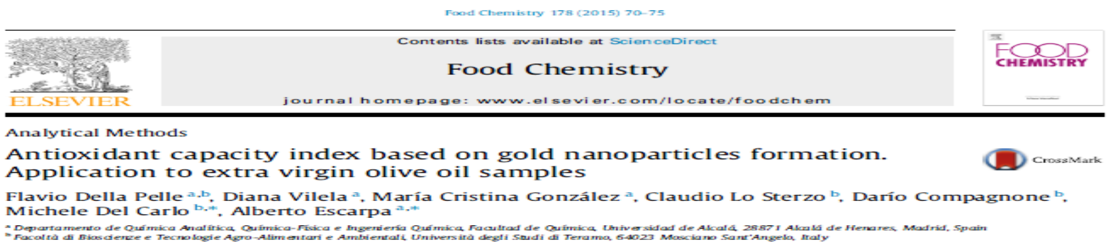




- **Antioxidant capacity evaluation (AoC):**
  (AuNPs-based AoC index)

- It works on aqueous/hydroalcoholic solutions

Total assay time: 15-25 min



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Analytical Methods

Antioxidant capacity index based on gold nanoparticles formation. Application to extra virgin olive oil samples

Flavio Della Pelle [a,b], Diana Vilela [a], María Cristina González [a], Claudio Lo Sterzo [b], Darío Compagnone [b], Michele Del Carlo [b,*], Alberto Escarpa [a,*]

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Metal nanoparticles (MNPs)

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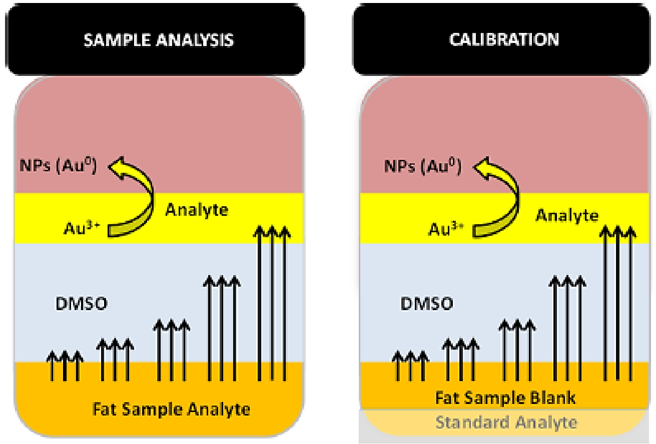
AuNPS colorimetric assay total polyphenols evaluation directly using lipidic matrices

AuNPs
Fat

AoC
Fat
Matrix Sample



- **Total polyphenols determination**
- **Extraction free**: directly applicable in fat sample matrix

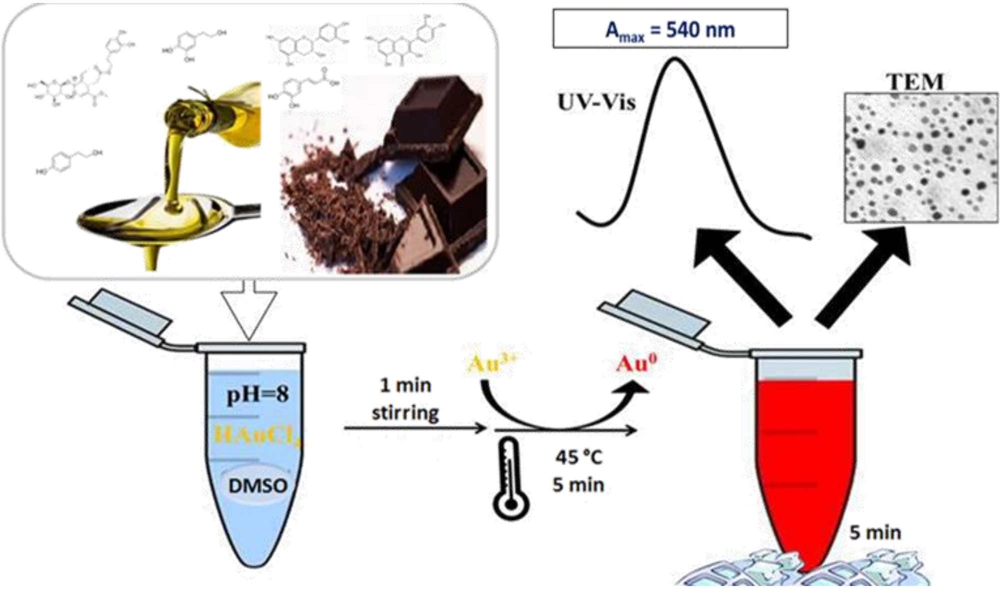
Total assay time: 10 min

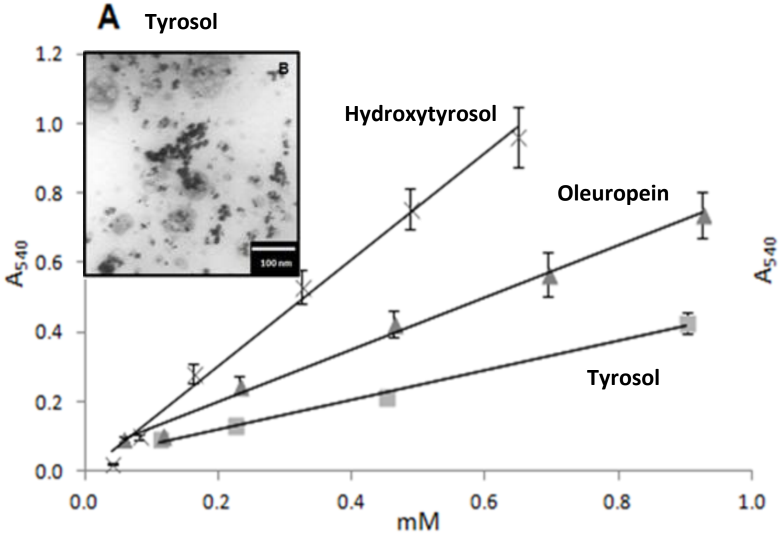
Metal nanoparticles (MNPs)

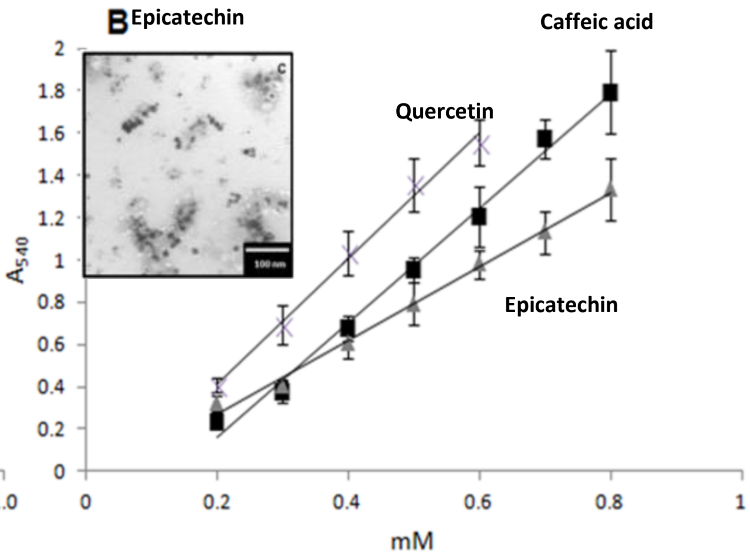
AuNPs
Fat

AoC
Fat
Matrix Sample

polyphenolic standards reactivity study :
(olive oil and chocolate/cocoa polyphenols standards)







Olive Oil and chocolate standards are able to form AuNPs

- LSPRmax ≈540nm
- $R^2 \geq 0.992$
- Good reproducibility (RSD ≤ 13, n.=3 inter-day)

(×) Hydroxytyrosol **R^2 = 0.992**
(y = 1.5371x – 0.0054)
(▲) Oleuropein **R^2 = 0.993**
(y = 0.7525x + 0.0509)
(■) Tyrosol **R^2 =0.995**
(y = 0.4237x + 0.037)

(×) Quercetin **R^2 = 0.993**
(y = 29.59x – 0.1756)
(■) Caffeic acid **R^2 = 0.993**
(y = 27.136x – 0.3841)
(▲) Epicatechin **R^2 = 0.994**
(y = 17.414x – 0.0753)

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Metal nanoparticles (MNPs)

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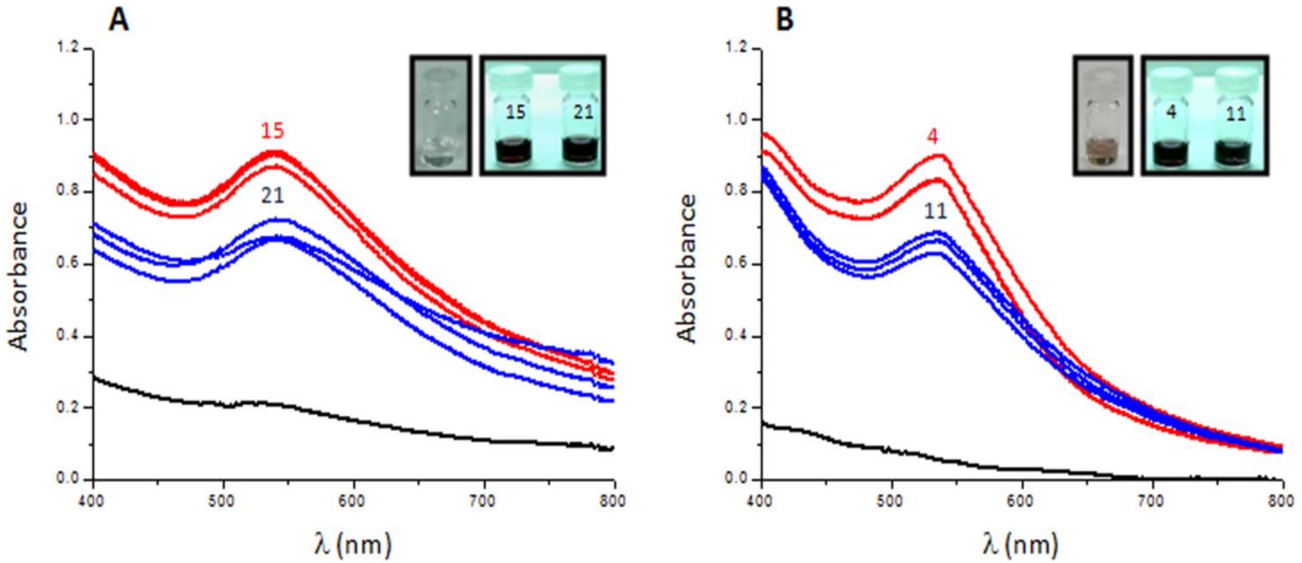
AuNPs
Fat

AoC
Fat
Matrix Sample

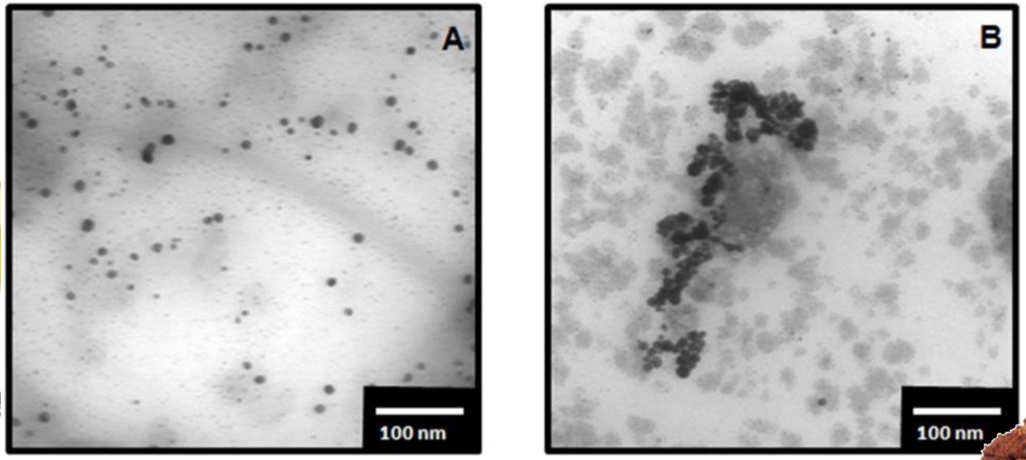
Samples challenged

- Olive oil **n° 28**
- Chocolate **n° 16**
- Cocoa powder **n° 59**

<u>*Oil samples*</u> **<u>*Chocolate and cocoa samples*</u>**



- **Recoveries between 90 and 110 %**
- **Tocopherol fortification 31.25-5000 mg L^{-1} no AuNPs formation**



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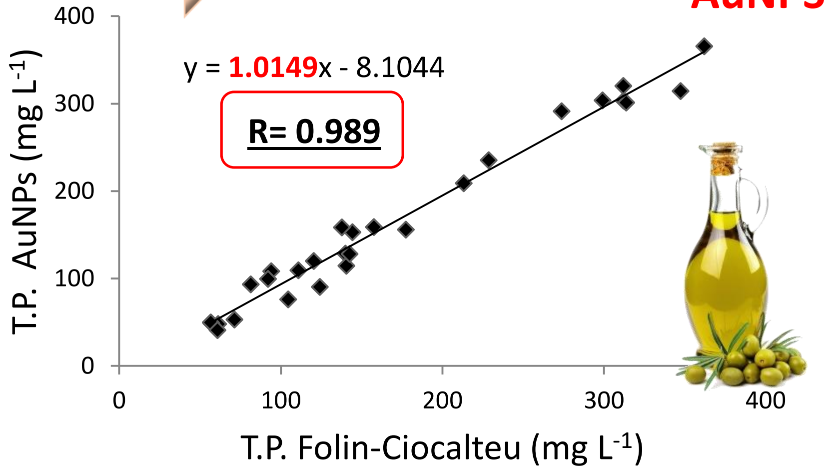
Metal nanoparticles (MNPs)

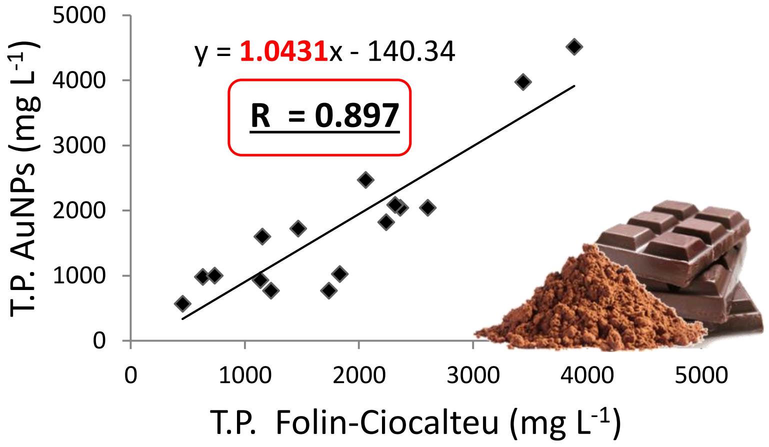
AuNPs
Fat

AoC
Fat
Matrix Sample

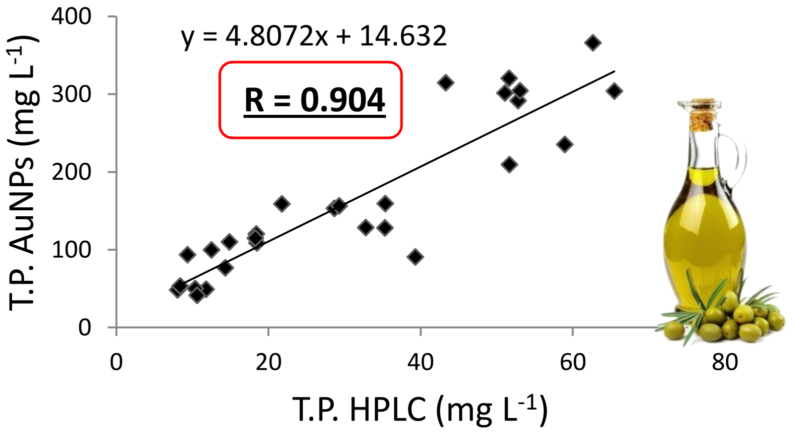
AuNPS method vs. F.C. and HPLC-Uv/DAD (Olive n°28 and chocolate n°16 samples)

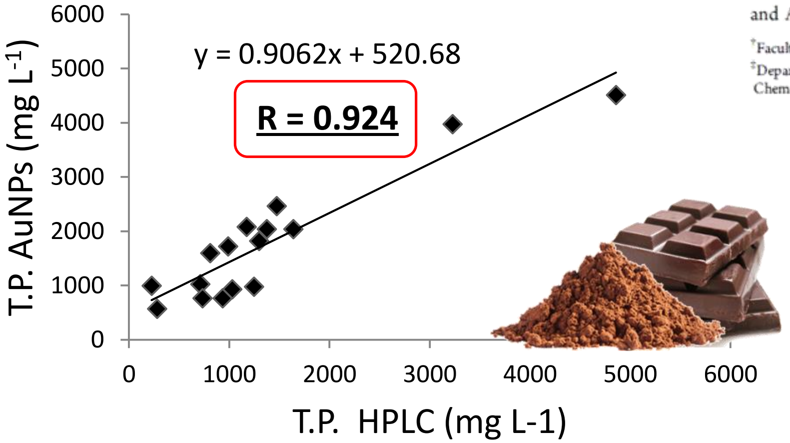
AuNPS vs. F.C.





AuNPS vs. HPLC





analytical chemistry Article pubs.acs.org/ac

Gold Nanoparticles-based Extraction-Free Colorimetric Assay in Organic Media: An Optical Index for Determination of Total Polyphenols in Fat-Rich Samples

Flavio Della Pelle,[†,‡] María Cristina González,[‡] Manuel Sergi,[†] Michele Del Carlo,[†] Dario Compagnone,*[,†] and Alberto Escarpa*[,‡]

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Underestimation HPLC oil samples: Escarpa A. et al., Anal. Chim. Acta, 427 (2001) 119-27; Weingerl V. et al., Acta Chim. Slov., 56 (2009) 698-703.

Metal nanoparticles (MNPs)

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AgNPs-based AoC and flavanols content Evaluation

AgNPs RT

Polyphenols Sensitive Detection

- **Sensitive AoC evaluation**

- pH (13)
- T (**Room Temperature**)
- Sensitive (LOD ≤ 0.4 μM gallic acid)

Total assay time: 10 min

AgNPs HT

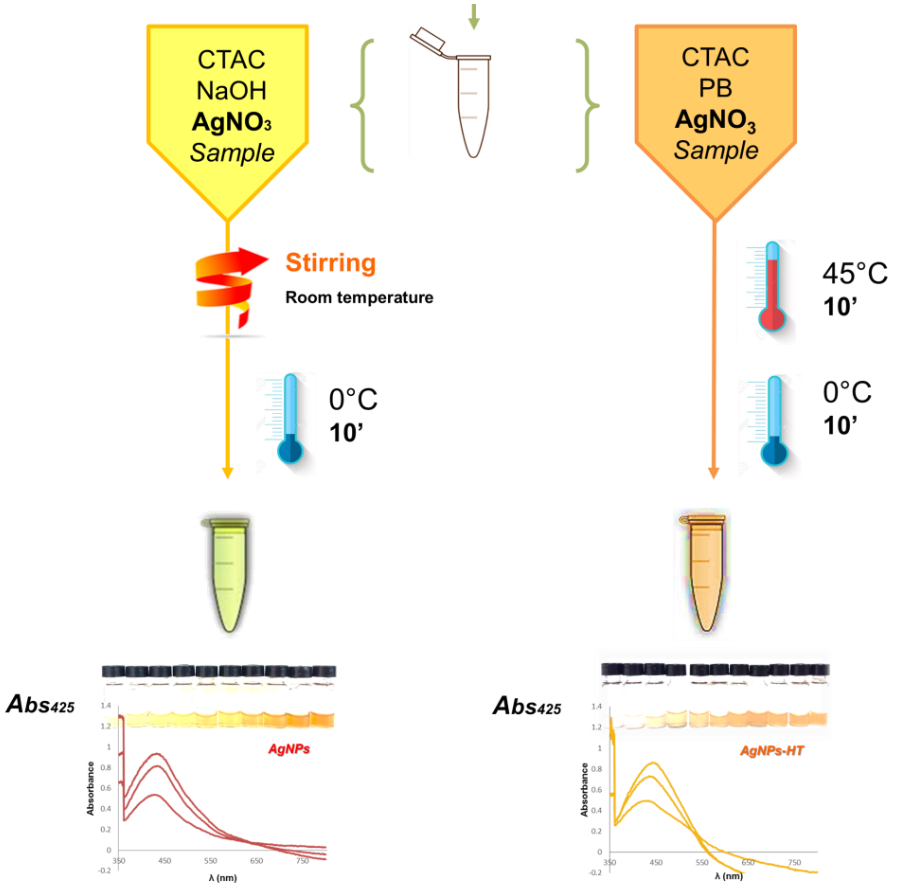
Polyphenols Class Selectivity

- **Flavanols assessment**

- pH (8,3)
- T (45°C)
- Sensitivity to the intrinsic antioxidant capcity

Total assay time: 10 min

AgNPs-based strategies

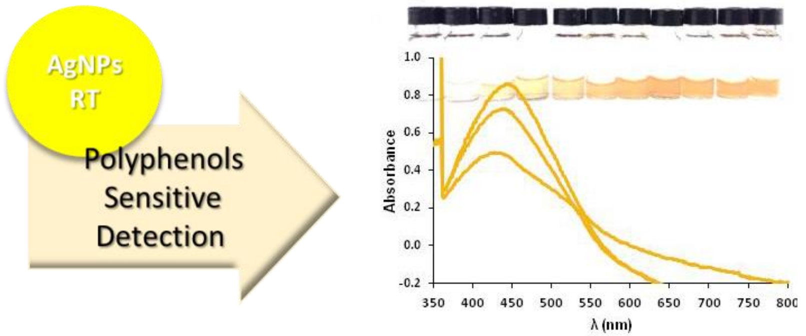


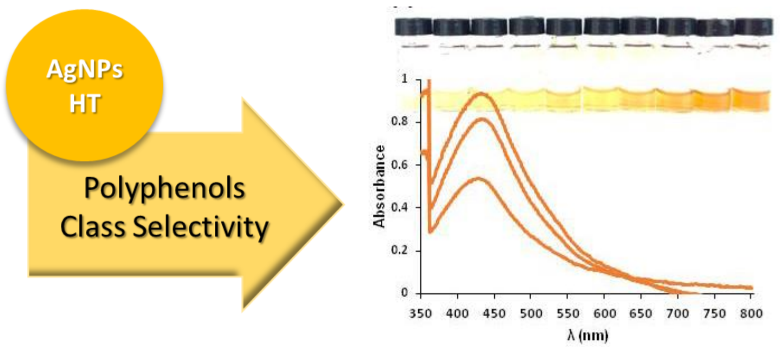
Metal nanoparticles (MNPs)

AgNPs Polyphenol sensing… polyphenolic standards Reactivity study

Analytical parameters obtained by the polyphenol standards dose–response curve employing the two proposed AgNPs-based method.

Standard	AgNPs-*RT*			AgNPs-*HT*		
	Linear range µM	Equation	R^2	Linear range µM	Equation	R^2
Caffeic acid	1.5–12.5	y = 0.029x + 0.191	0.993			
Catechin	0.25–6	y = 0.056x + 0.331	0.991	10–100	y = 0.005x + 0.409	0.996
Catecol	1.5–30	y = 0.010x + 0.371	0.991			
Chlorogenic acid	3–25	y = 0.018x + 0.284	0.994			
Epicatechin	1–7.5	y = 0.041x + 0.286	0.991	20–90	y = 0.008x + 0.166	0.993
Epigallocatechin	0.5–7.5	y = 0.044x + 0.315	0.991	20–200	y = 0.003x + 0.365	0.996
Ferulic acid	10–125	y = 0.002x + 0.303	0.991			
Gallic acid	1–15	y = 0.019x + 0.280	0.991	200–600	y = 0.001x + 0.289	0.998
Kaempferol	5–65	y = 0.006x + 0.266	0.994	20–250	y = 0002x + 0522	0.999
Myricetin	1–6	y = 0.064x + 0.223	0.992	100–200	y = 0005x − 0280	0.991
Quercetin	1–12.5	y = 0.048x + 0.164	0.992	100–200	y = 0.005x − 0.115	0993
Rutin	2–20	y = 0.023x + 0.199	0.993	30–90	y = 0.007x + 0.289	0996
Trolox	1–20	y = 0.018x + 0.385	0.992			





Metal nanoparticles (MNPs)

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AgNPs RT — Polyphenols Sensitive Detection

AgNPs HT — Polyphenols Class Selectivity

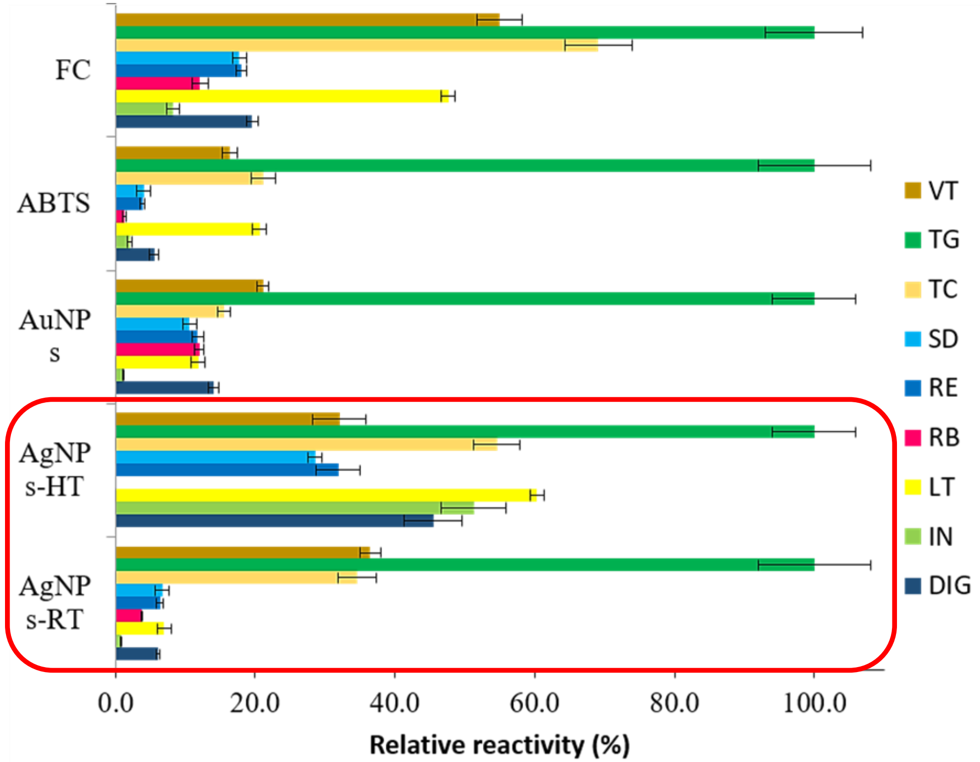
n° 9 teas and infusions

AgNPs Polyphenol sensing… samples reactivity study

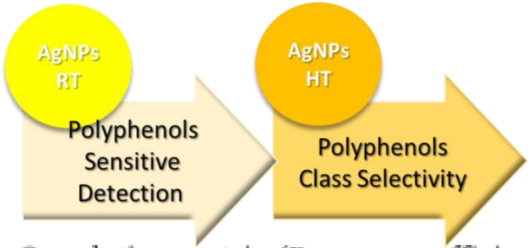
VT: Vanilla Tea
TG: Green Tea
TC: Classic Tea
SD: sogni d'oro infused
RE: Relax infused
RB: Rosa di bosco Infused
LT: Lemon Tea
IN: Finocchio infused
DIG: Digestiva infused

AgNPs-*RT* , AgNPs-*HT* vs. F.C, ABTS and AuNPs

Sample / Method	DIG (g Kg^{-1})	RSD (%)	IN (g Kg^{-1})	RSD (%)	LT (g Kg^{-1})	RSD (%)	RB (g Kg^{-1})	RSD (%)	RE (g Kg^{-1})	RSD (%)	SD (g Kg^{-1})	RSD (%)	TC (g Kg^{-1})	RSD (%)	TG (g Kg^{-1})	RSD (%)	VT (g Kg^{-1})	RSD (%)
AgNPs-RT	8.66	4	1.20	9	9.91	5	5.31	3	9.12	8	9.62	7	49.50	8	143.01	3	52.19	4
AgNPs-HT	11.10	9	12.52	9	14.73	5			7.78	10	6.98	14	13.33	6	24.42	7	7.82	12
AuNPs	18.63	5	1.52	7	15.64	2	15.86	5	15.58	7	14.03	5	20.56	6	132.35	3	27.95	4
ABTS	3.03	12	1.12	14	11.26	7	0.70	14	2.13	9	2.21	12	11.55	8	54.57	5	8.92	7
FC	5.98	4	2.51	11	14.54	3	3.70	10	5.51	4	5.42	5	21.10	7	30.54	8	16.79	6



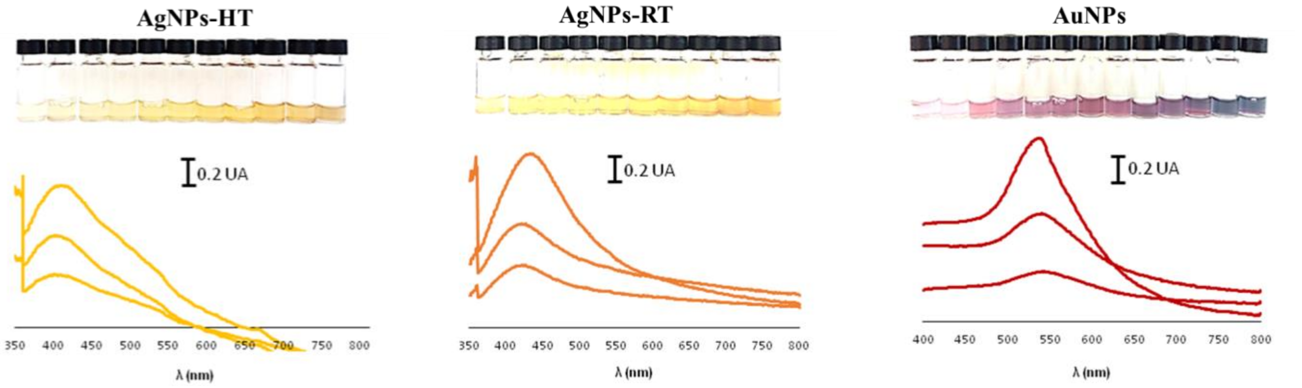
Metal nanoparticles (MNPs)

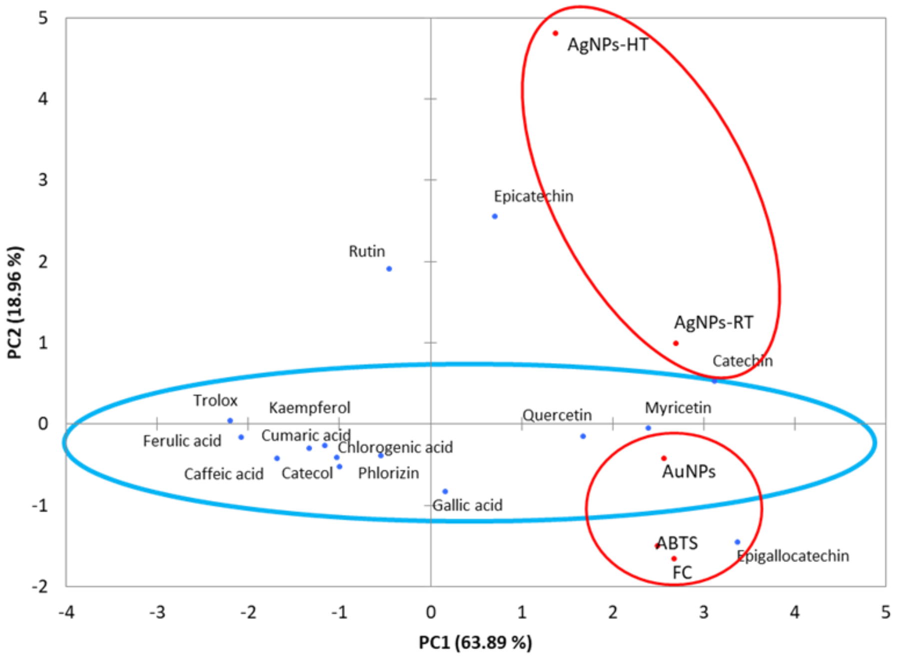


AgNPs-*RT* , AgNPs-*HT* vs. F.C, ABTS and AuNPs

Correlation matrix (Pearson coefficient) for all the antioxidant capacity methods tested.

	ABTS		FC		AgNPs-*HT*		AgNPs-*RT*		AuNPs	
ABTS	1	(p = 0)	0.876	(p = 0.002)	0.891	(p = 0.001)	0.956	(p = 0.000)	0.977	(p = 0.000)
FC	0.876	(p = 0.002)	1	(p = 0)	0.733	(p = 0.025)	0.913	(p = 0.001)	0.801	(p = 0.009)
AgNPs-*HT*	0.891	(p = 0.001)	0.733	(p = 0.025)	1	(p = 0)	0.770	(p = 0.015)	0.826	(p = 0.006)
AgNPs-*RT*	0.956	(p = < 0.0001)	0.913	(p = 0.001)	0.770	(p = 0.015)	1	(p = 0)	0.950	(p = < 0.0001)
AuNPs	0.977	(p = < 0.0001)	0.801	(P = 0.009)	0.826	(p = 0.006)	0.950	(p = < 0.0001)	1	(p = 0)





Metal nanoparticles (MNPs)

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Polyphenol UHPLC–MS/MS evaluation comparison with the AgNPs-HT assay

Sample / Standard	DIG (g Kg-1)	IN (g Kg^{-1})	LT (g Kg^{-1})	RB (g Kg^{-1})	RE (g Kg^{-1})	SD (g Kg^{-1})	TC (g Kg^{-1})	TG (g Kg^{-1})	VT (g Kg^{-1})
Caffeic acid	3.36E-02*	2.42E-03	3.19E-03	1.56E-02	3.93E-02	3.44E-02	2.19E-04	<LOQ	6.48E-04
Catechin	<LOQ**	<LOQ	1.00E-01	1.86E-03	1.54E-03	1.29E-03	2.65E-01	8.61E-01	4.91E-01
Catecol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Chlorogenic acid	1.71E-01	2.05E-01	5.74E-02	2.44E-01	5.36E-01	5.09E-01	1.25E-01	8.11E-02	5.68E-02
Cumaric acid	4.69E-03	1.77E-04	<LOQ	<LOQ	1.45E-03	6.12E-03	1.03E-03	<LOQ	3.07E-04
Epicatechin	<LOQ	<LOQ	9.64E-02	<LOQ	4.62E-03	1.48E-01	2.64E-01	9.93E-01	5.39E-01
Epigallocatechin	<LOQ	<LOQ	2.09E-01	<LOQ	<LOQ	<LOQ	4.19E-01	2.28E+01	7.48E-01
Ferulic acid	1.27E-02	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Gallic acid	7.42E-03	<LOQ	6.54E-01	3.23E-02	<LOQ	<LOQ	9.17E-01	4.74E-01	8.34E-01
Kaempferol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Myricetin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Phlorizin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Quercetin	4.07E-02	<LOQ	<LOQ	5.74E-02	<LOQ	3.07E-03	<LOQ	<LOQ	<LOQ
Rutin	2.49E-01	<LOQ	<LOQ	<LOQ	<LOQ	1.92E-02	<LOQ	<LOQ	<LOQ
Trolox	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Total phenols	**2.06E+00**	**2.08E-01**	**1.53E+00**	**3.79E-01**	**2.38E+00**	**3.52E+00**	**2.94E+00**	**2.61E+01**	**3.49E+00**
Phenols fraction	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Flavonols (%)	56.9	0.0	53.3	23.1	19.4	41.0	64.4	97.9	72.9
o-diphenols (%)	61.4	99.9	100.0	100.0	80.4	76.6	100.0	100.0	98.3
m-phenols (%)	38.6	0.1	0.0	0.0	19.2	23.4	0.0	0.0	1.7

Flavanols content trend

UHPLC-MS/MS TG > VT > TC > DIG > LT > SD > RB > RE > IN

AgNPs-*HT* TG > VT > TC > DIG > LT > SD > RB > RE > IN

VT: Vanilla Tea
TG: Green Tea
TC: Classic Tea
SD: sogni d'oro infused
RE: Relax infused
RB: Rosa di bosco Infused
LT: Lemon Tea
IN: Finocchio infused
DIG: Digestiva infused

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Simple and rapid silver nanoparticles based antioxidant capacity assays: Reactivity study for phenolic compounds

Flavio Della Pelle, Annalisa Scroccarello, Manuel Sergi, Marcello Mascini, Michele Del Carlo, Dario Compagnone*

Faculty of Bioscience and Technology for Food, Agriculture and Environment, University of Teramo, 64023 Teramo, Italy

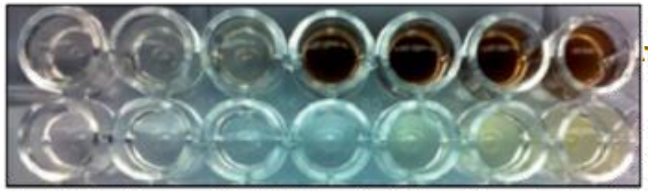
Metal nanoparticles (MNPs)

Nano Ceria

Polyphenols evauation

Optimization

$[CeO_2]$ 0.0025, 0.005, 0.01, 0.1, 1, 2, and 4%

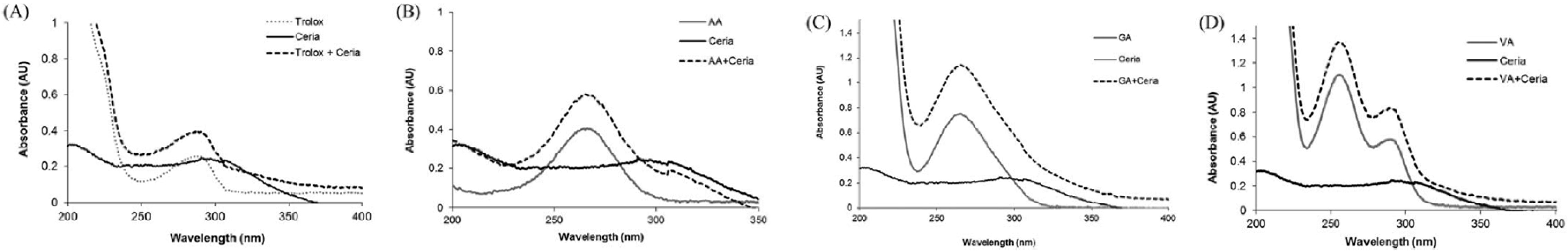


Caffeic acid (0,45 mM) reacted $[CeO_2]$

$[CeO_2]$= 4%

Uv-vis spectra of ceria nanoparticles dispersion (13 ppm) in the presence and abesence of selected antioxidants.

Trolox   Ascorbic acid   Gallic acid   Vanillic acid

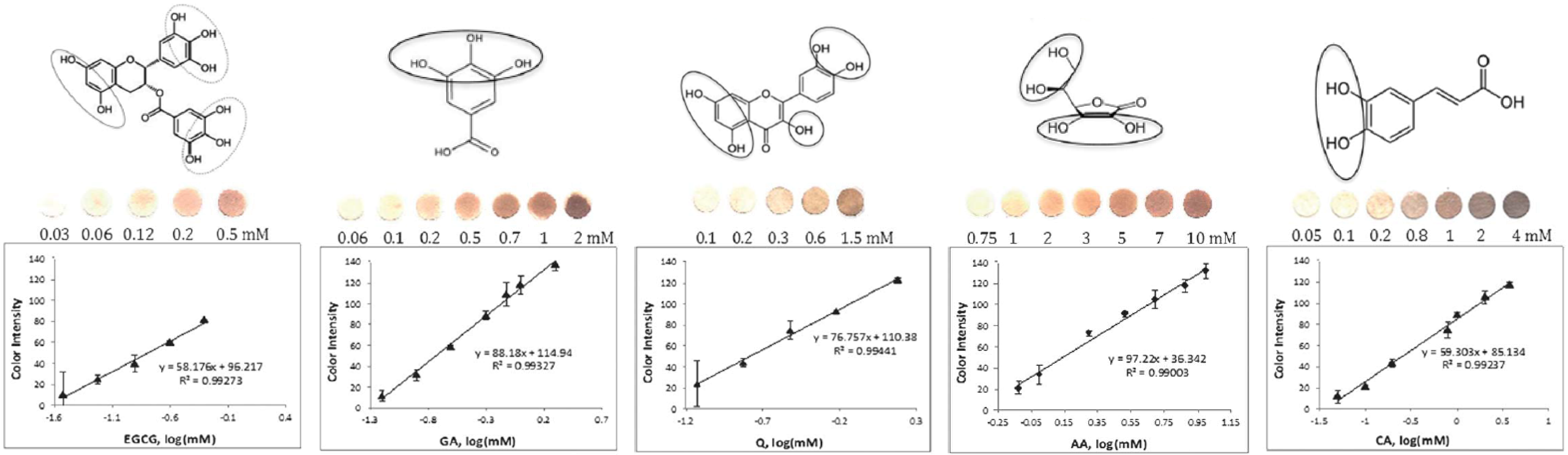


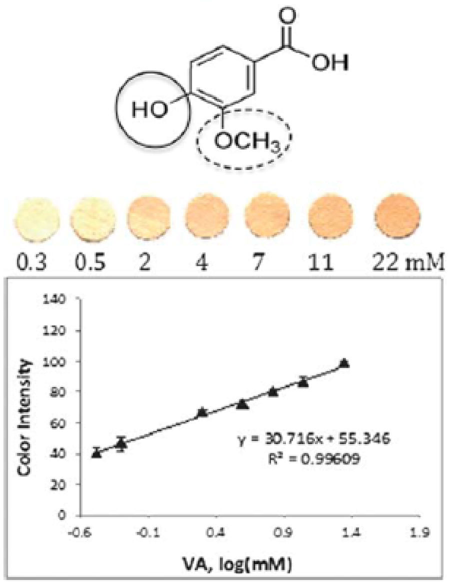
$$2\ CeO_2 + 3\ C_6H_8O_6 \rightarrow Ce_2O_3 + 3\ C_6H_6O_6 + 2\ H_2O$$

From dispersed system

to paper support

Metal nanoparticles (MNPs)

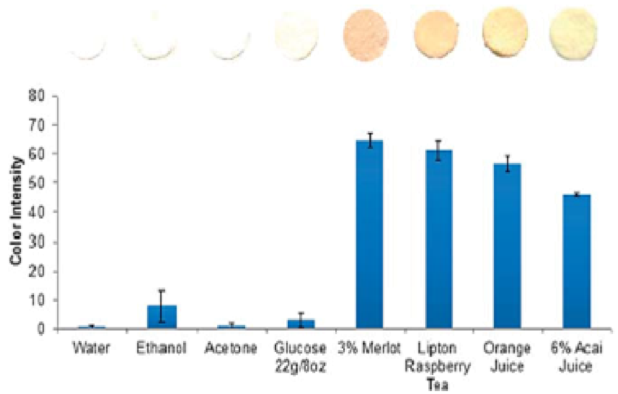




Tested interfering compounds

Common lab solvent:
- water,
- ethanol,
- acetone

Common sugar presents in:
- juice,
- wine,
- commercial teas



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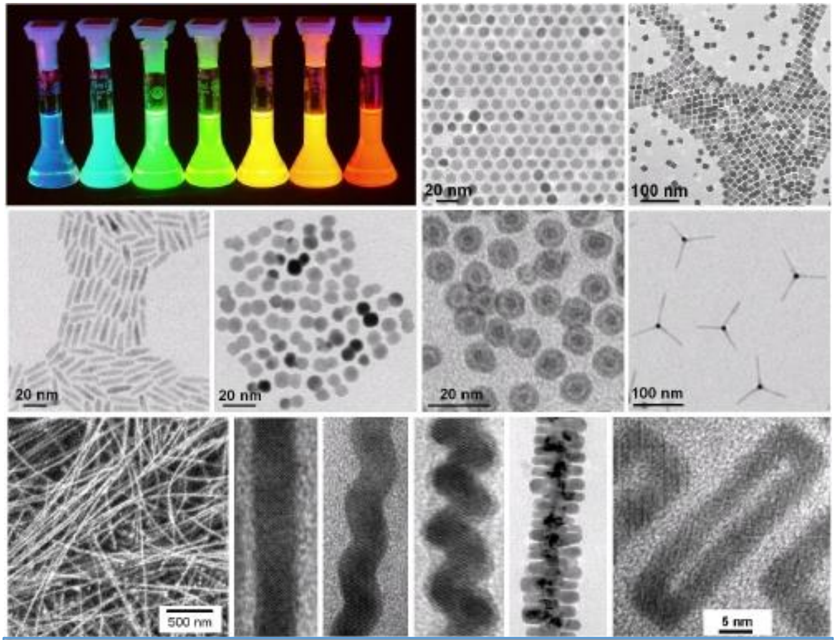
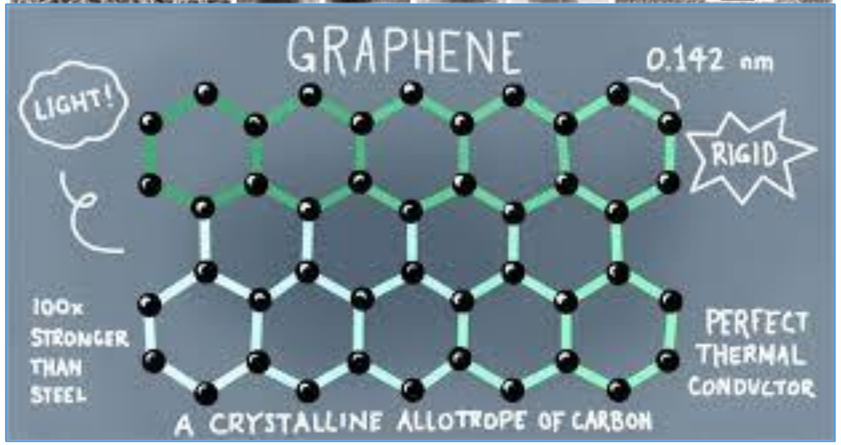
Cite this: DOI: 10.1039/c2an36205h

Portable ceria nanoparticle-based assay for rapid detection of food antioxidants (NanoCerac)

Erica Sharpe, Thalia Frasco, Daniel Andreescu and Silvana Andreescu*

Nanomaterials employed in electrochemical sensor



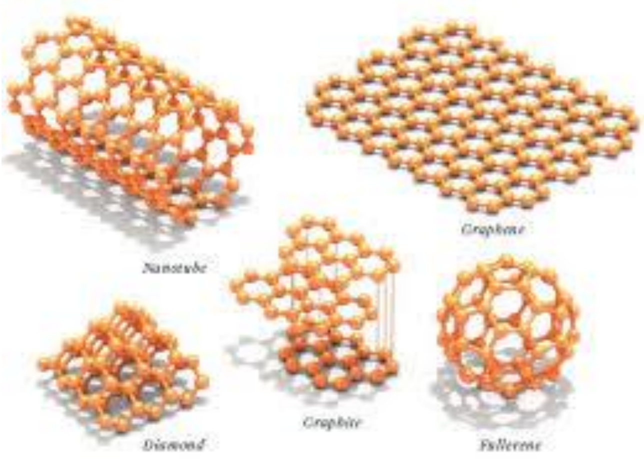


Carbon based nanomaterials:

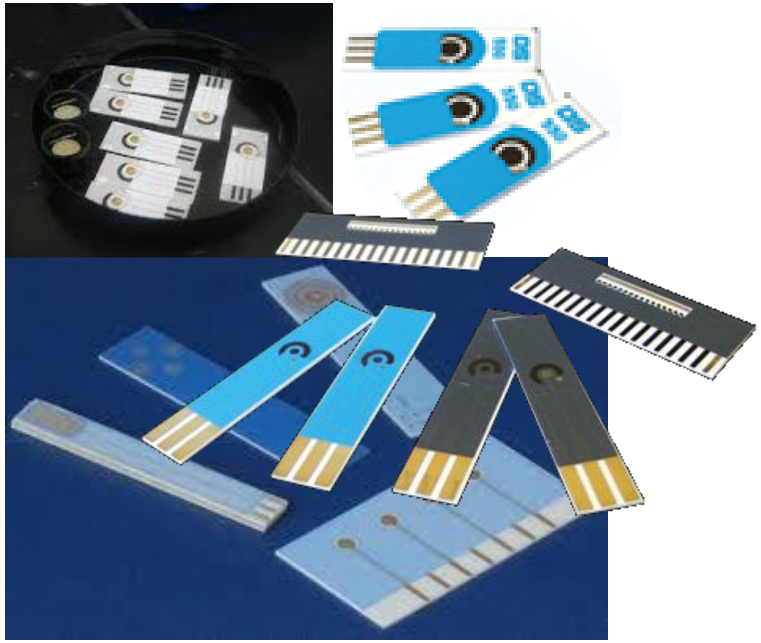
- Nanotubes
- Fullerenes
- Graphene
- Etc…

Nanoparticles:

- Metal nanoparticles
- Metal Oxide nanoparticles

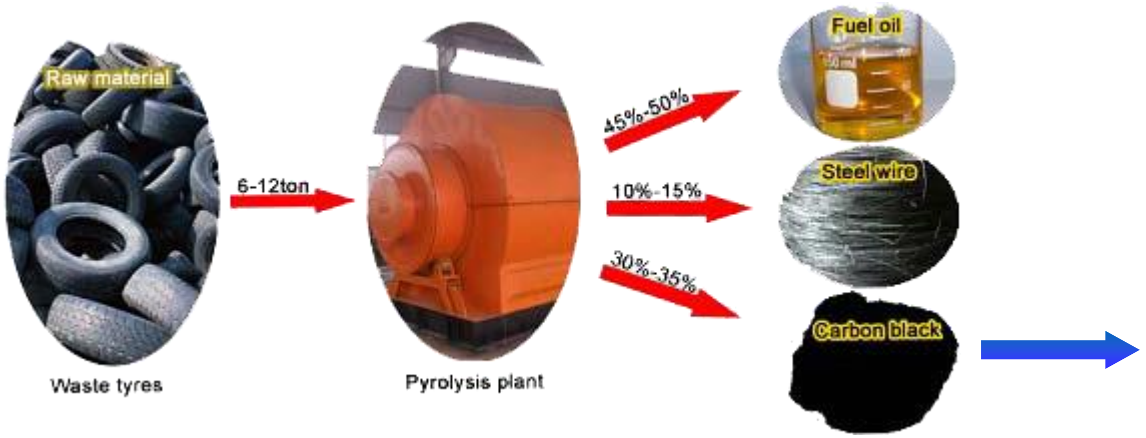


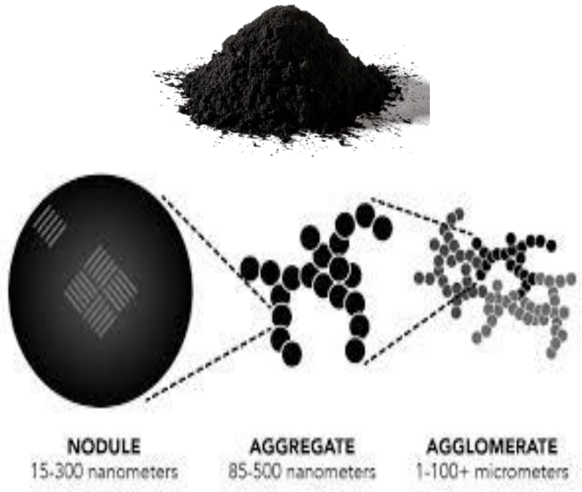
Screen printed electrodes

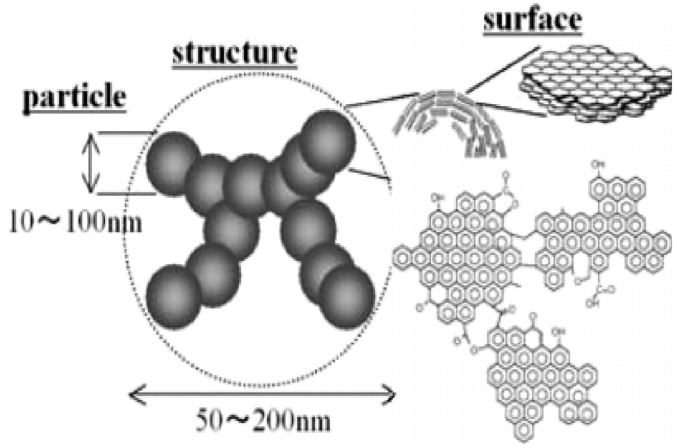


Carbon based nanomaterials (Carbon Black, CB)

Carbon black is a material produced by the incomplete combustion of heavy petroleum products. It is mainly used as a reinforcing filler in tires and other rubber products. In plastics, paints, and inks, carbon black is used as a color pigment







Electrocatalysis	Selectivity
High surface	Sensitivity
Resistance to fouling	Reproducibility
Faster eletron transfer	Improving separation performance

CB compared with other nanomaterials:

Very low cost
No synthesis
No impurities due to synthesis
Easily dispersible
Large number of defect sites

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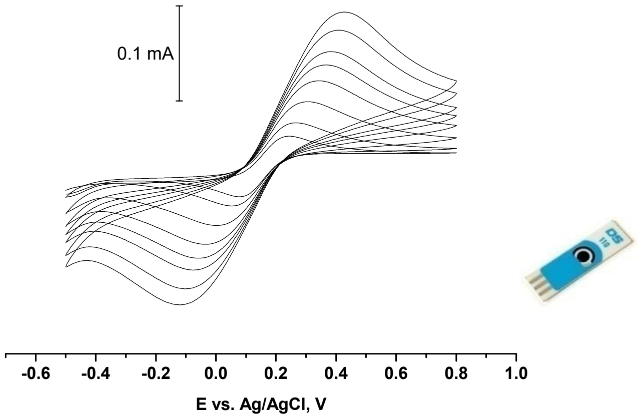
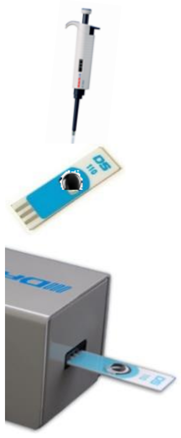
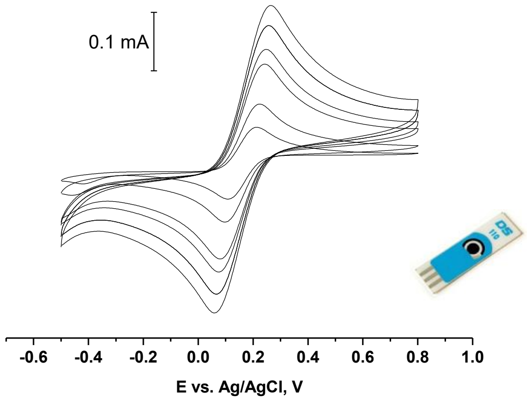
SPE-CBNPs electrochemical behaviour for ferrycianide

Carbon SPE

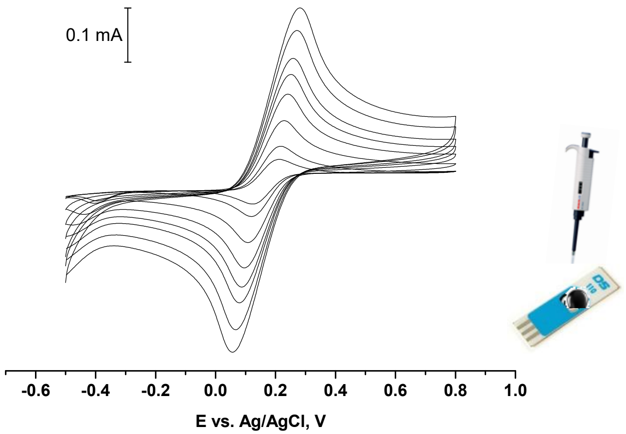


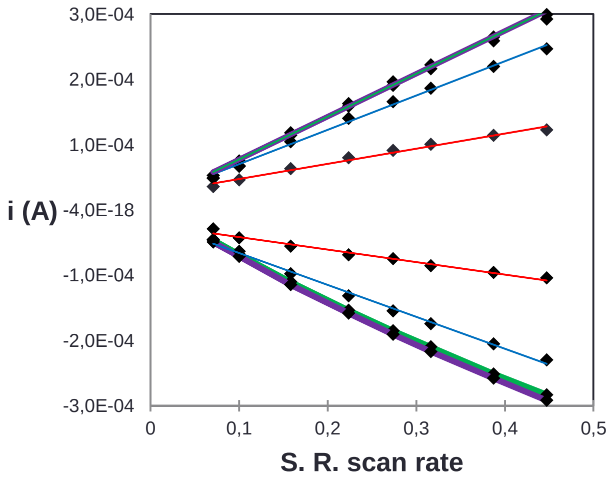


Graphene/Carbon SPE (DS110-GPH)

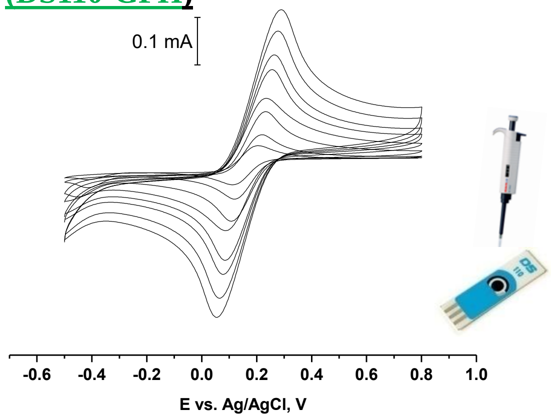


Carbon-CB SPE





Graphene/Carbon-CB SPE (DS110-GPH)



CB modified SPE demonstrates a better electron transfer

Graphene-like nanomaterials

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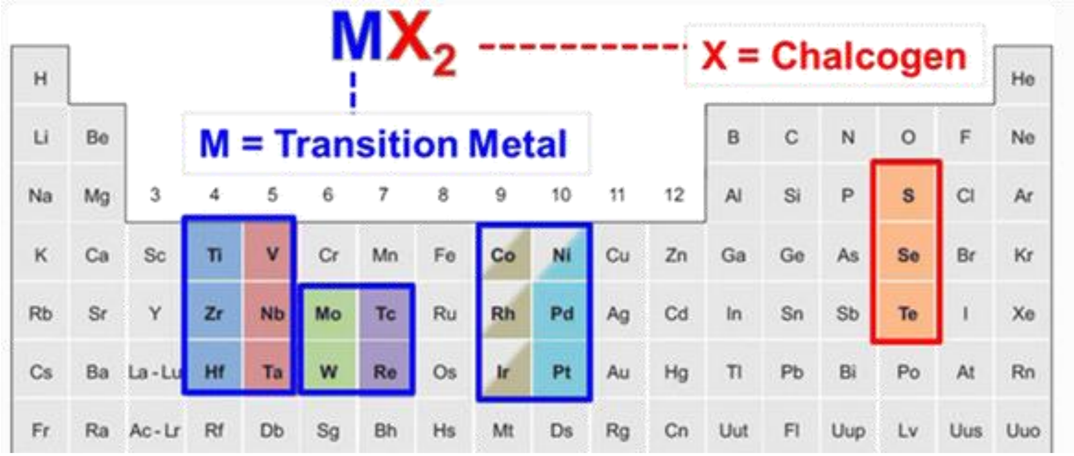
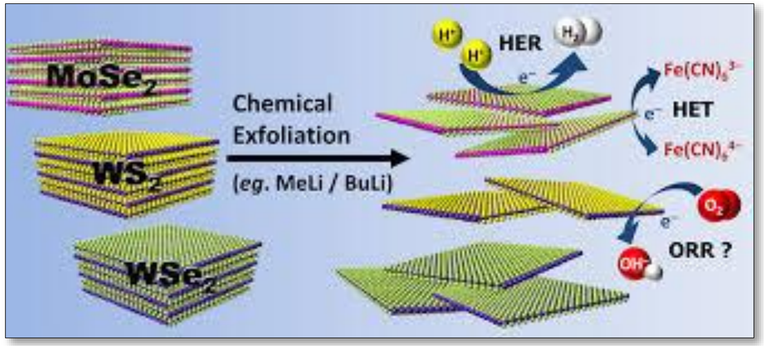
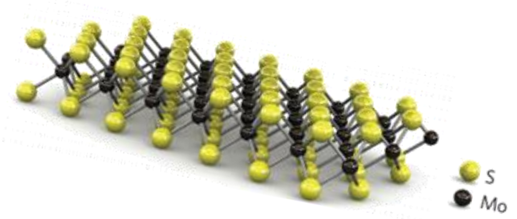
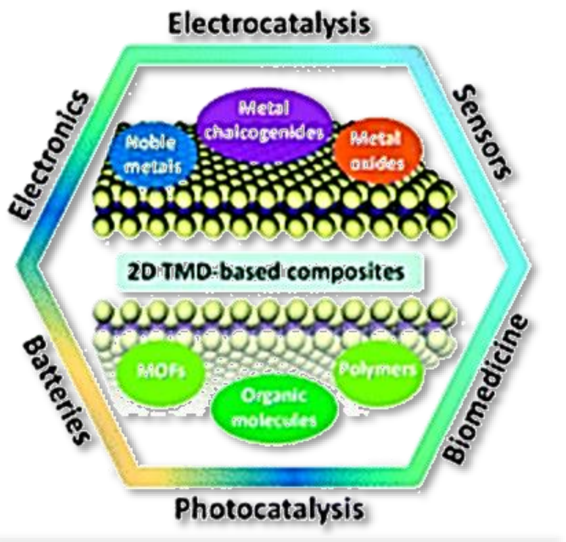
Graphene-like two-dimensional layered nanomaterials, transition metal dichalcogenides (TMDs)





Eng, A. Y. S., Ambrosi, A., Sofer, Z., Simek, P., & Pumera, M. (2014). Electrochemistry of transition metal dichalcogenides: strong dependence on the metal-to-chalcogen composition and exfoliation method. *ACS nano*, *8*(12), 12185-12198.





Tan, C., & Zhang, H. (2015). Two-dimensional transition metal dichalcogenide nanosheet-based composites. *Chemical Society Reviews*, *44*(9), 2713-2731.

- TMDs nanosheets Easy to prepare
- Unique electrical, optical , and mechanical properties
- Large surface area, low cost, stability
- Metallic and semi-conducting electrical capabilities
- Widely in employed in hydrogen evolution reaction (HER) and energy storage
- Few applications in (bio)sensors employed in food analysis
- Tunable electrocatalytic properties /intercalatable morphologies

Graphene-like nanomaterials

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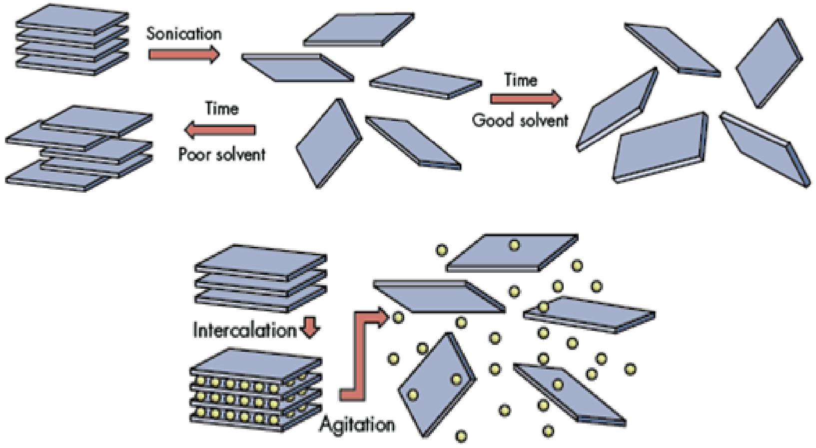
TMDs and TMDs-based nanocomposite for sensor and biosensors

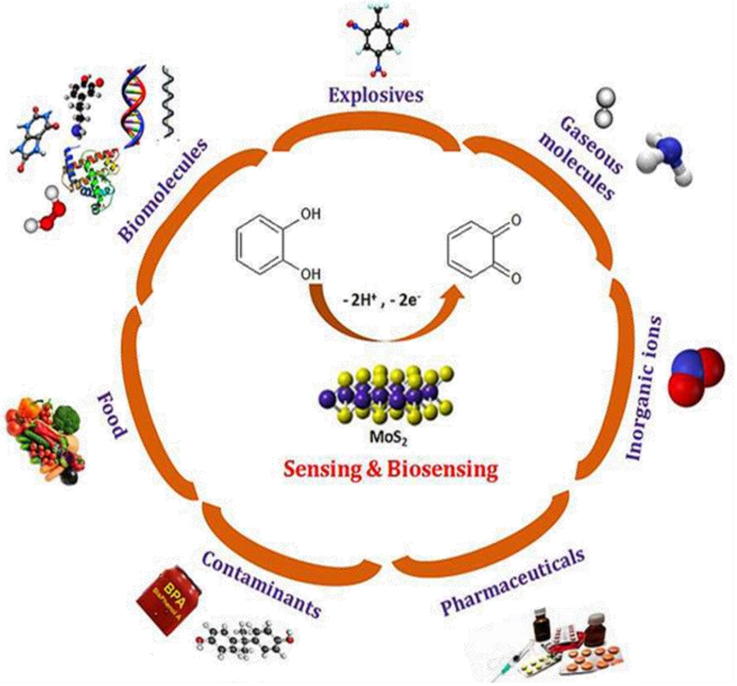
2D NMs can form heterostructures with layers of varied materials and with a thickness of one or two atoms, and thus synergistically improve their physicochemical properties.



Exfoliation using intercalating materials/ appropriate solvent
(single- or few-layer TMDs nanosheets**)**

TMDs-based nanocomposites/ Hybrid nanoarchitectures

These strategies avoiding restacking, narrow potential window, low conductivity, fouling, etc.
improving the general electrochemical performance



TMDs-based sensors and biosensors growing field and holds great promise

Alarcon-Angeles, G., Palomar-Pardavé, M., & Merkoçi, A. (2018). 2D Materials-Based Platforms for Electroanalysis Applications. *Electroanalysis*, *30*(7), 1271-1280.
Sinha, A., Tan, B., Huang, Y., Zhao, H., Dang, X., Chen, J., & Jain, R. (2018). MoS 2 Nanostructures for Electrochemical Sensing of Multidisciplinary Targets: A Review. *TrAC Trends in Analytical Chemistry*.

Graphene-like nanohybrids materials

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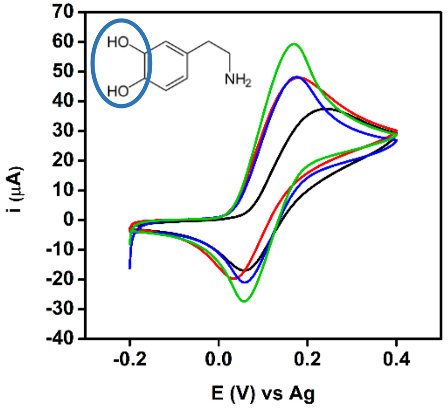
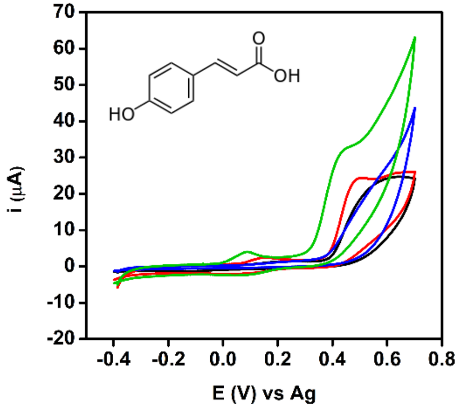
Electrochemical response towards common electroactive species
Interesting response for o-diphenols

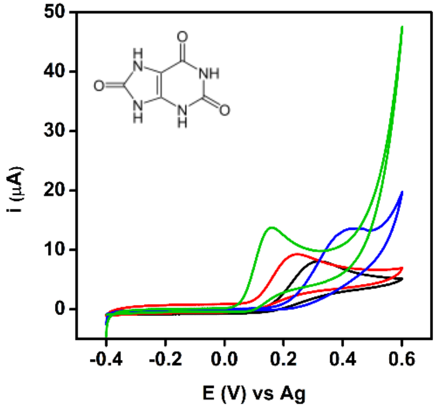
Dopamine



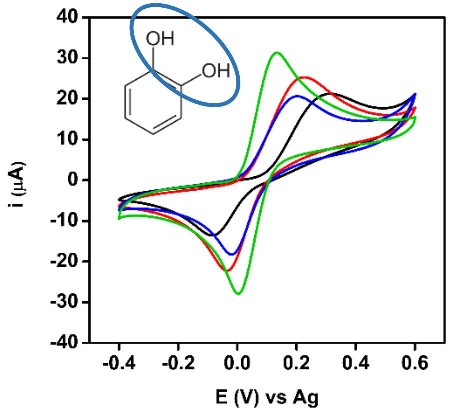
Coumaric acid



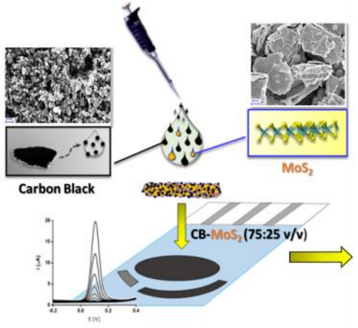
Ascorbic Acid



Catechol



CVs of 1 mmol L^{-1} of each compound at a scan rate of 50 mV s^{-1}.



- Dopamine and Catechol showed an improvement in the peak-to-peak separation and increased peak intesities.
- Coumaric acid and ascorbic acid showed a negative shift and improved peak intensities.
- SPE-CB-MoS2 anodic peak intensity decrease was in the ≤2 % and ≤ 10% for Catechol/Dopamine and Uric acid/Coumaric acid, respectively, after 10 scans

Graphene-like nanohybrids materials

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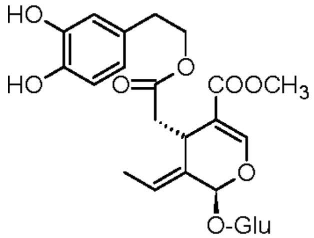
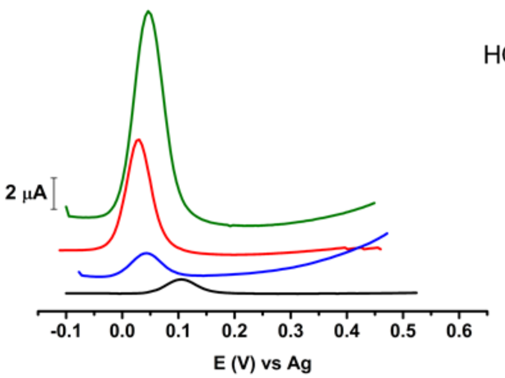
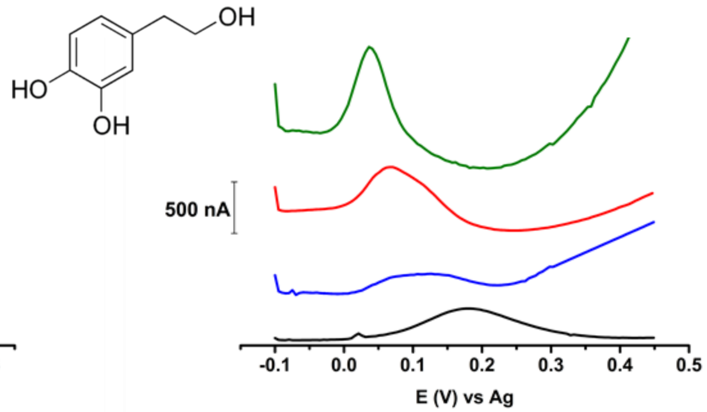
A case study: olive oil ortho-phenols

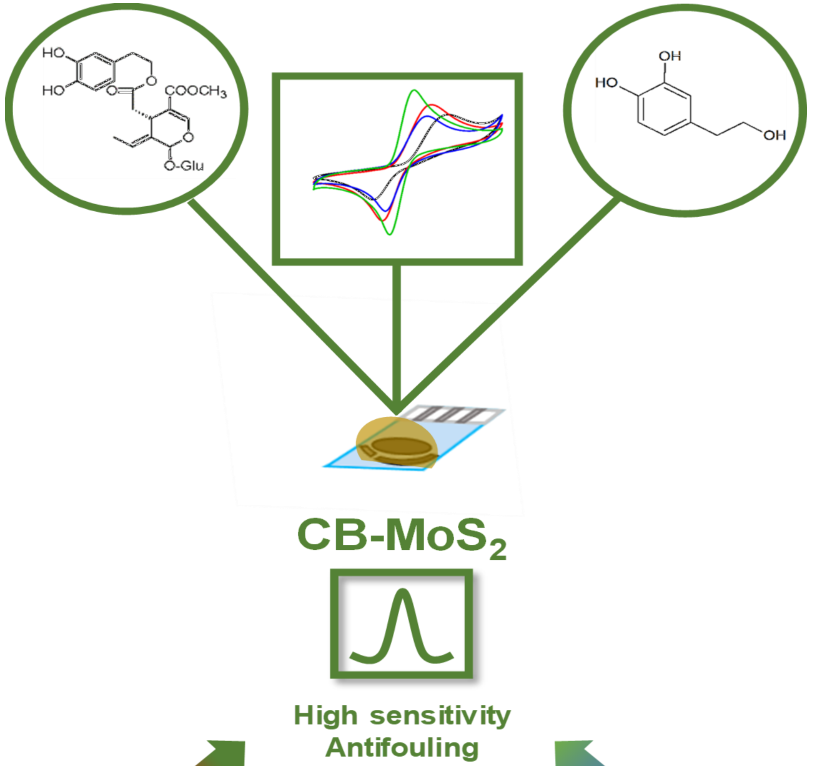
OLEUROPEIN





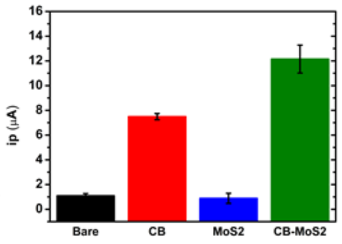
HYDROXYTYROSOL

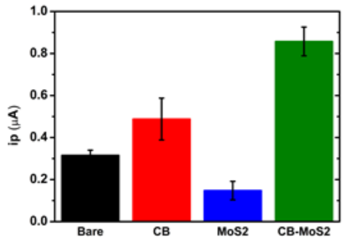


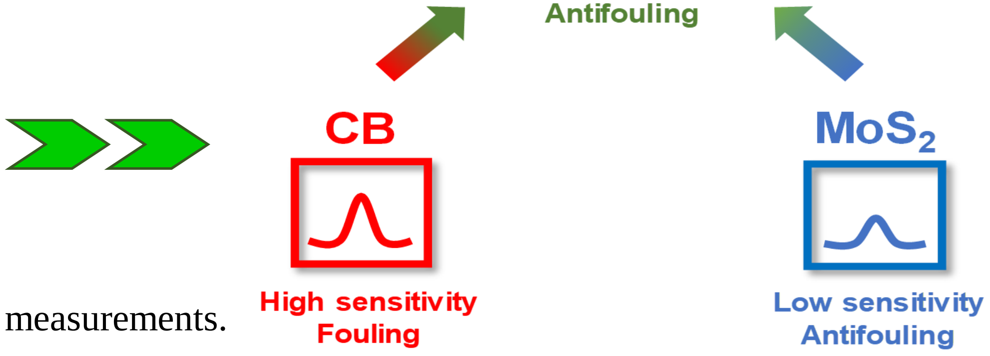


•Ortho-phenols are the main contributors to the antioxidant capacity of Olive Oil phenolic fraction.

•An increased oxidation current was observed for both o-diphenols in the modified electrodes







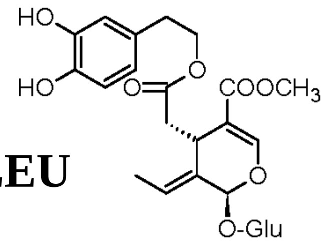
Fouling Effect was evaluated as the retained peak intensity after 10 consecutives DPV measurements.

The obtained values: 38% for Bare, **53% for CB,** 84% for MoS2 and 86% for CB-MoS2 modified SPE for OLEU

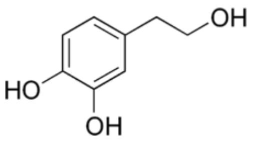
Graphene-like nanohybrids materials

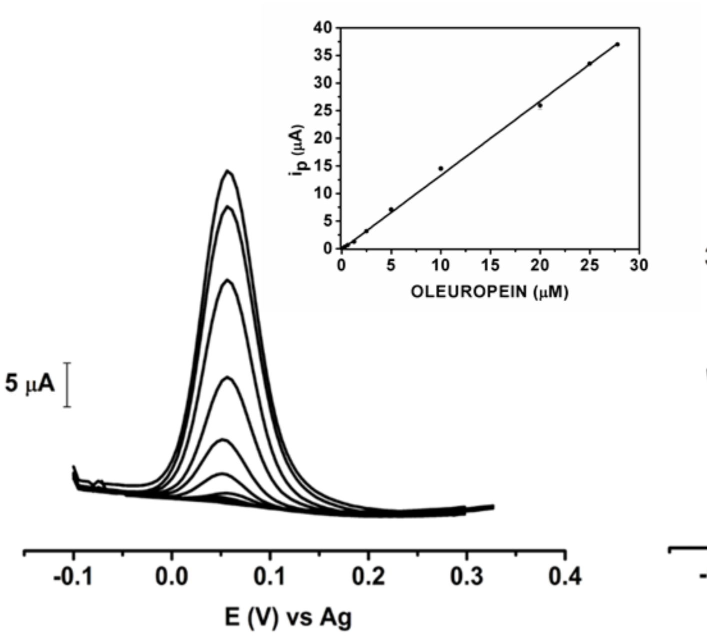
Analytical performance towards olive oil ortho-phenols (differntial pulse voltammetry)

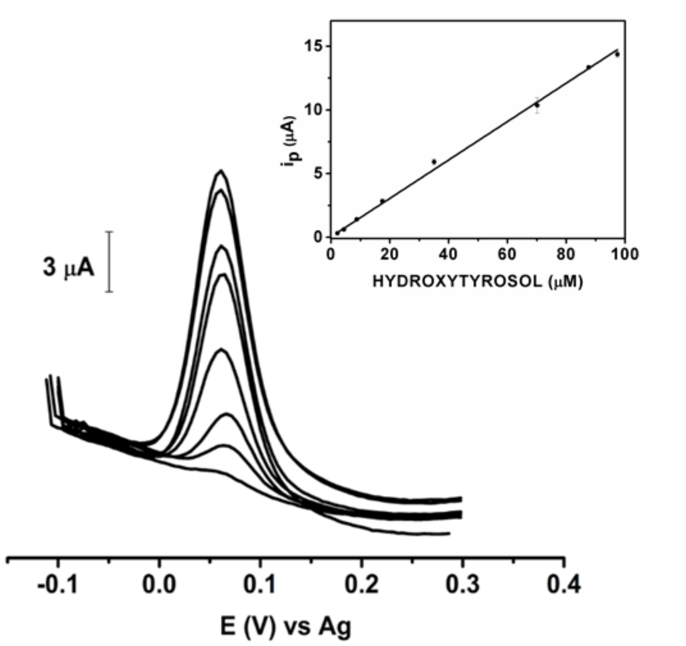
OLEU



HTYR







	OLEU	HTYR
LOD (µM)	0.12	1.06
LOQ (µM)	0.32	2.20
Linear range (µM)	0.39-28	3.54-100
R^2	0.997	0.991
Reproducibility (RSD) (n=5)	9%	8%

Regression equations

ip(µA)=-0.05(±0.02)+1.33(±0.02) [OLEU](µM)

ip(µA)=0.041(±0.007)+0.151(±0.002)[HTYR](µM)

Graphene-like nanohybrids materials

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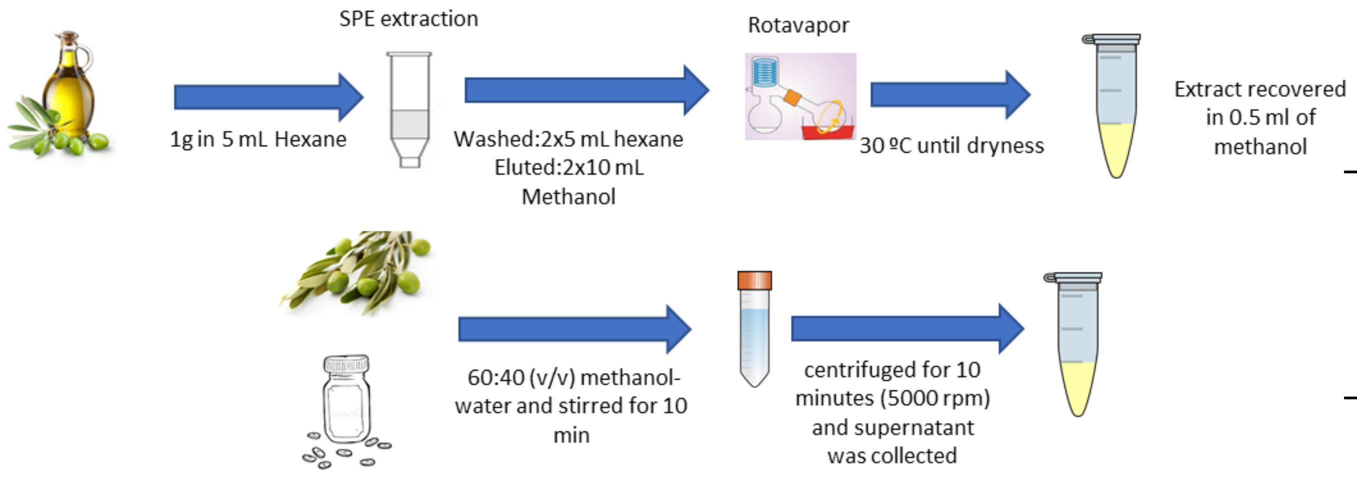
Sample treatment and analysis



Recoveries in extracts

Matrix	OLEU eq (ppm) Found in the extract	OLEU (ppm) added	OEU eq (ppm) found	Recovery (%)
Supplement	1.21±0.09	1	2.11±0.07	94±4
		3	4.15±0.29	98±7
Olive Leaf	0.38±0.14	1	1.39±0.18	103±7
		3	3.32±0.24	95±9
Olive Oil	0.32±0.06	1	1.40±0.07	108±6
		3	2.95±0.30	98±8

For recoveries calculation this formula has been employed: [(Oleuropein concentration obtained with fortified sample - Oleropein concentration obtained with unfortified sample)/Oleuropein concentration added]*100

Results obtained by sensor and HPLC-UV

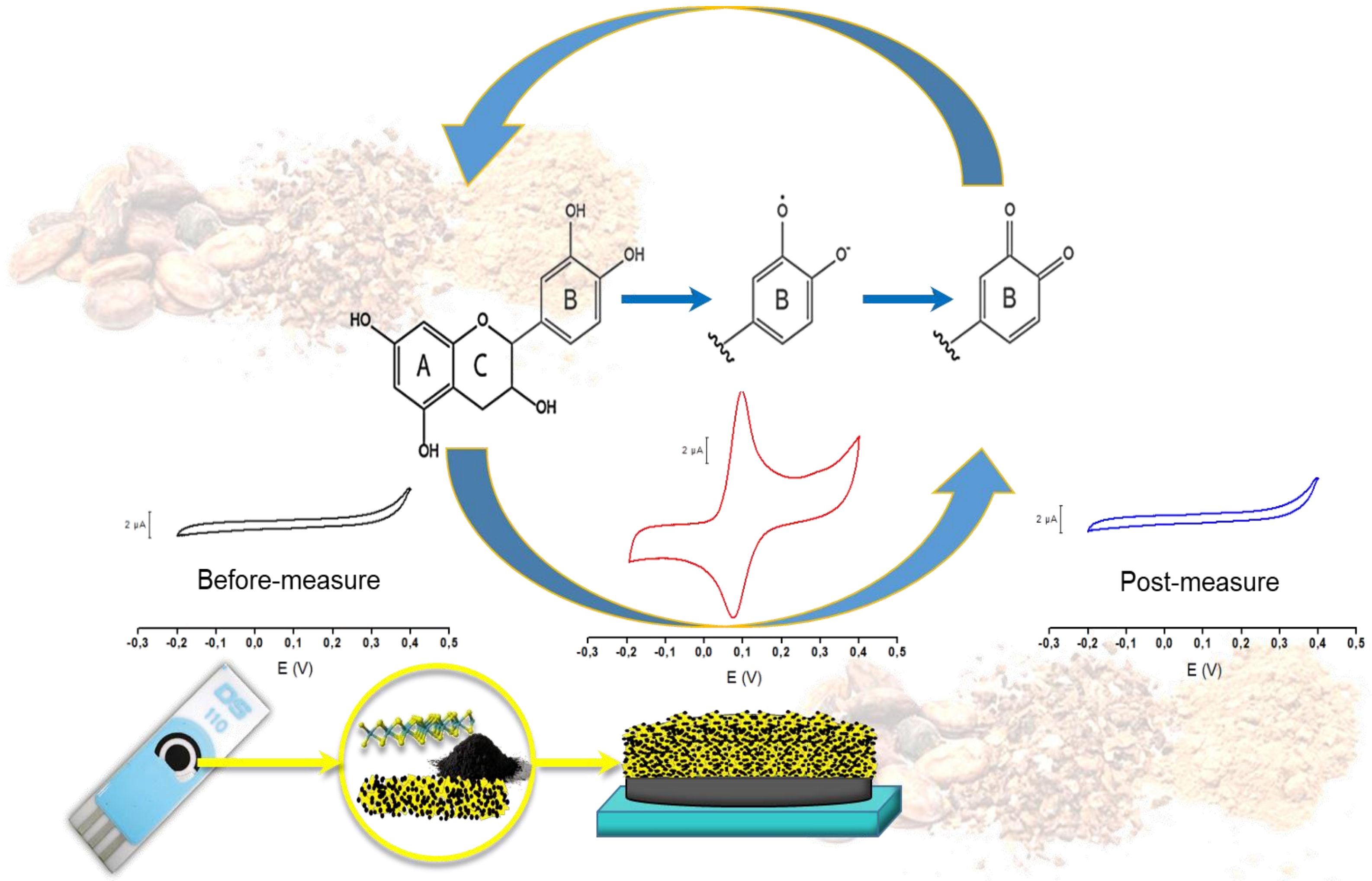
	$CB-MoS_2$ SPE		HPLC-UV		
Sample	Oleuropein eq. (mg Kg^{-1})	RSD (%)	o-diphenols (mg Kg^{-1})	RSD (%)	RE (%)
Dietary Supplement	5708±562	10	5534±277	5	7%
Olive Leaf 1	1286±55	4	1302±91	7	-1%
Olive Leaf 2	1193±97	8	1007±50	5	18%
Olive Oil 1	129±16	13	115±2	2	12%
Olive Oil 2	156±15	12	164±18	11	-4%
Olive Oil 3	45±3	7	36±6	15	15%

→ r=0.995

*Data are reported as mean±standard deviation **RSD=Relative Standard deviation***RE=Relative Error

Graphene-like nanohybrids materials

A case study: Cocoa polyphenols



(4) Graphene-like nanohybrids materials

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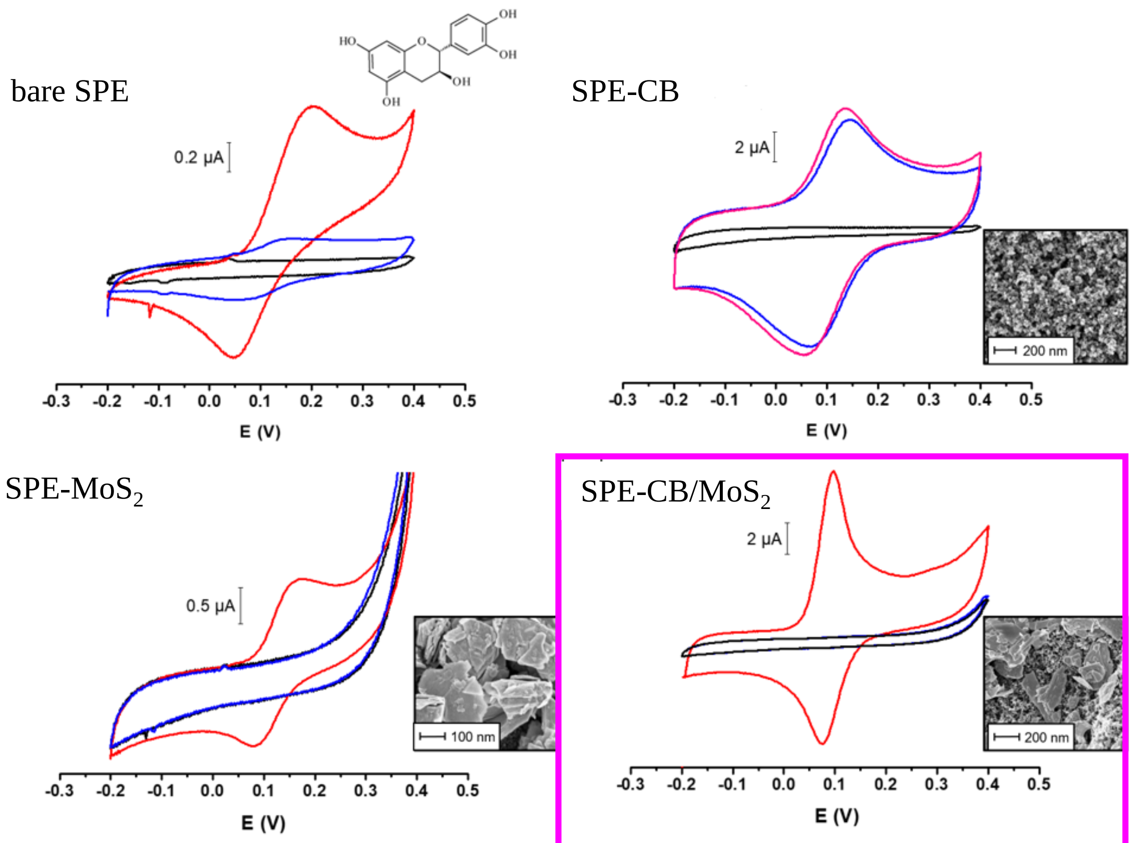
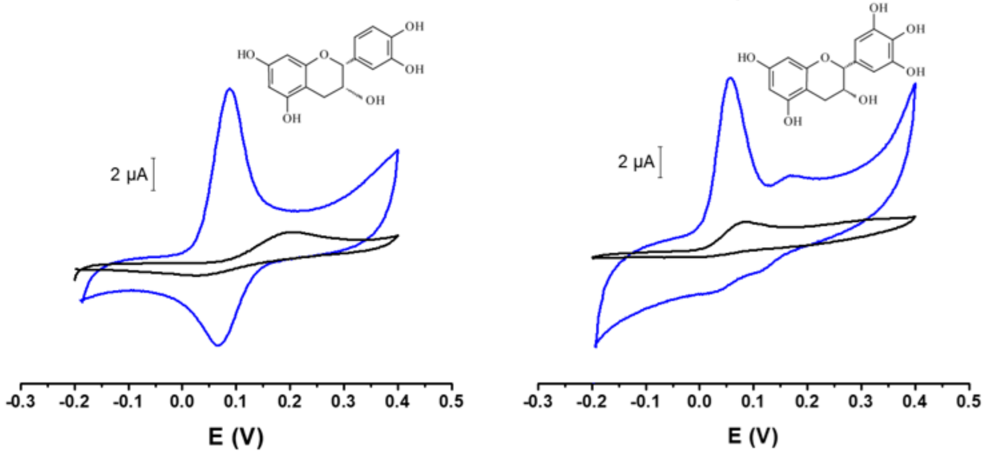
CATECHIN



Anti-Fouling properties

EPICATECHIN **EPIGALLOCATECHIN**



(5) Graphene-like nanohybrids materials

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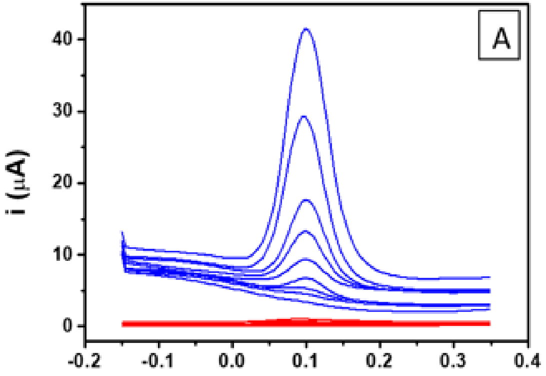
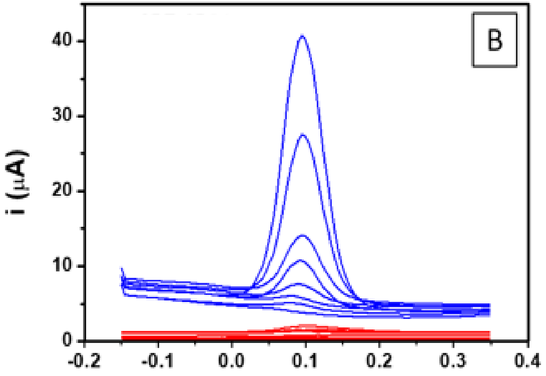
Standard calibration curve

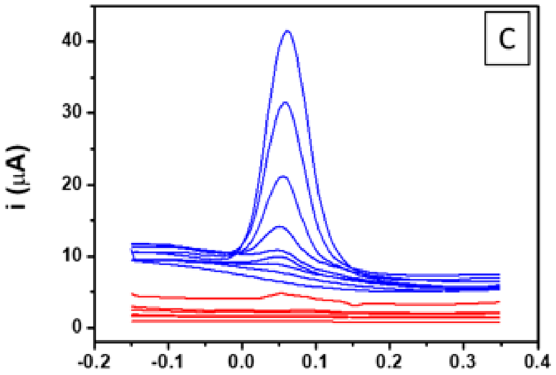
EPICATECHIN



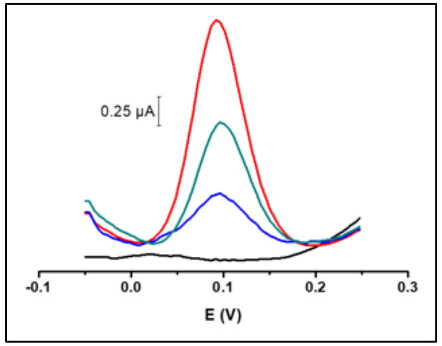
CATECHIN



EPIGALLOCATECHIN



Fortified cocoa samples



+ 0,25 μM catechin

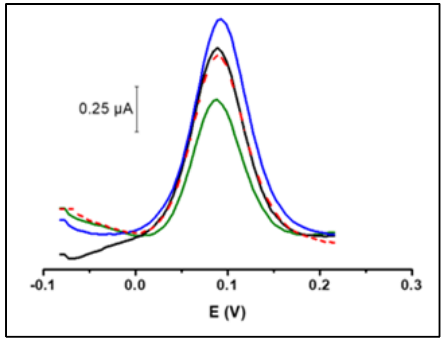
+ 0,5 μM catechin

Cocoa mix

Analytical characteristics of the SPE-CB/MoS_2 sensor employed for CT, EP, and EG detection.

	Linear Range (μmol L^{-1})	R^2	Sensitivity (μA L $μmol^{-1}$)	LOD (μmol L^{-1})
CT	0.1-25	0.998	1.12	0.18
EP	0.1-25	0.998	1.18	0.17
EG	0.1-25	0.998	1.10	0.18

[1]LODs were calculated as 3σ/slope ratio, where σ is the standard deviation of the mean value for 10 voltammograms of the blank. Analytical characteristics calculated using the mean value of three calibration curves.



Low polyphenols content

Medium polyphenols content

High polyphenols content

n= 5 repetition after n° 59 cocoa measurement

Graphene-like nanohybrids materials

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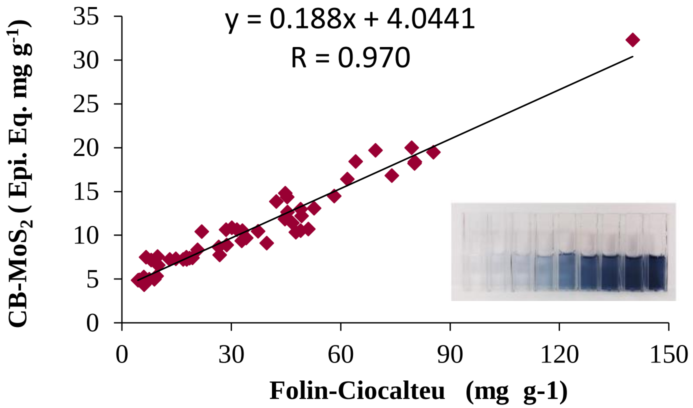
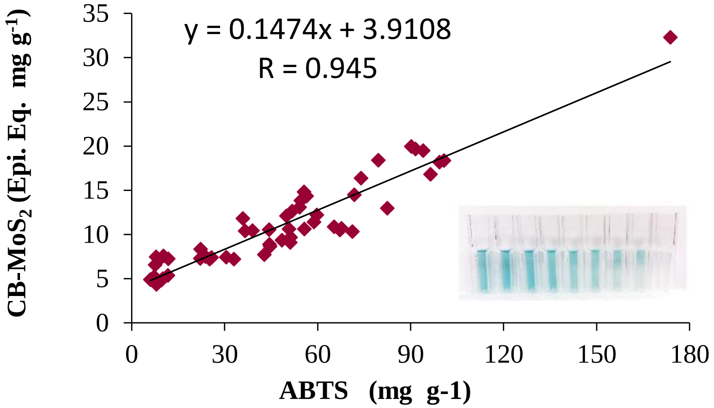
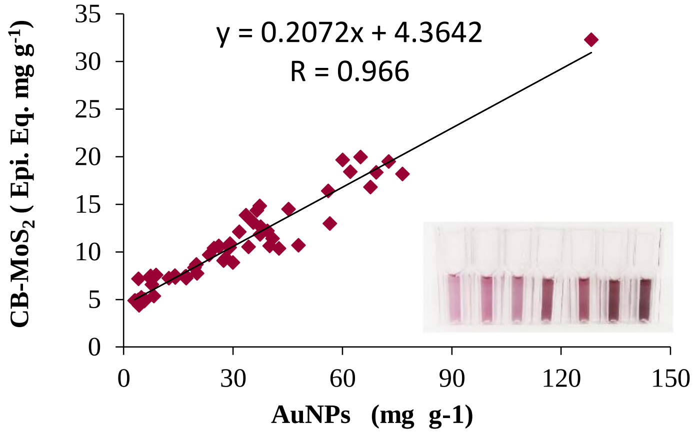
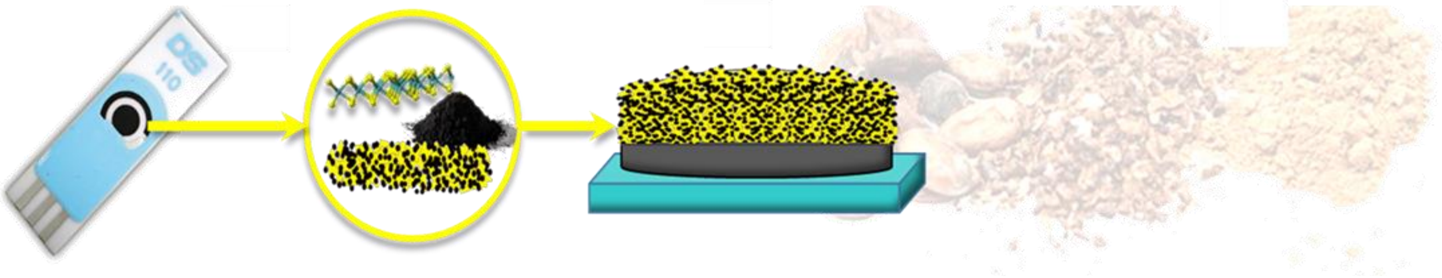
Data correlation
Optical assay vs. Electrochemical
n= 59 sample









Conclusions

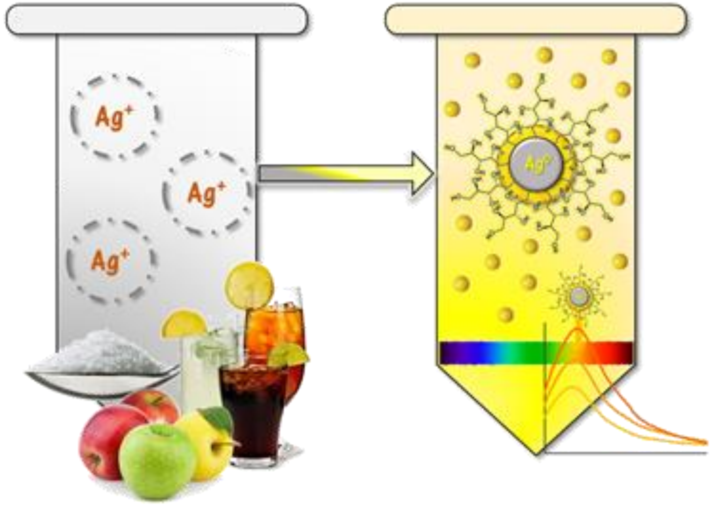
- *The use of MNPs with optical detection, allows the evaluation of TP and/or AOC in a rapid way and can be alternative to the most used methods. The main advantage relies on the possibility, for some of the developed assay, to work without extraction from the samples (e.g., for olive oil) or with simplified assay based on visual assessment (e.g. on paper).*

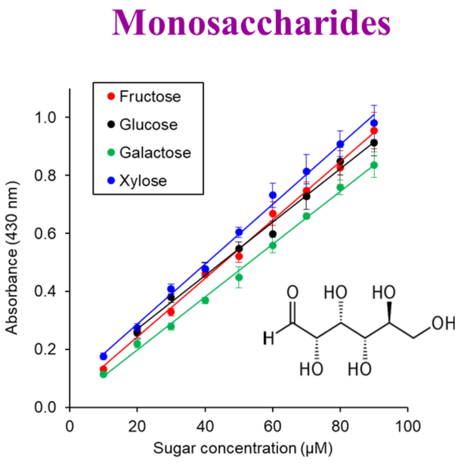
- *The use of electrochemical sensors and sensing strategies, alternative to classical methods can be of great value for the sensitivity and assessment of different classes of polyphenols (i.e., o-diphenols vs. monophenols) giving important information about foods stability (shelf-life). The 'tunable' and unique features of nanomaterials and the possibility to combine different types of nanomaterials give more options and possible advantages over existing methods; particularly, increased sensitivity, selectivity and long term stability of the sensing systems.*

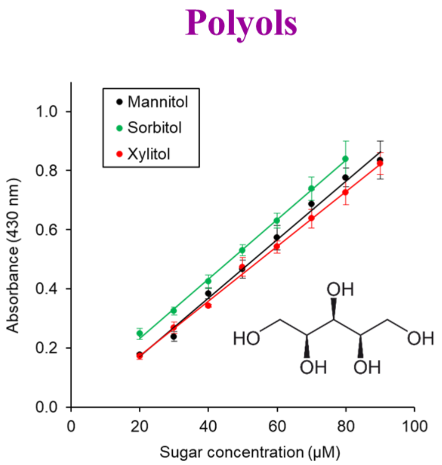

RED
OX
OX
RED
Men+
Me0
Ag0
Work
in
progress
Future
perspectives

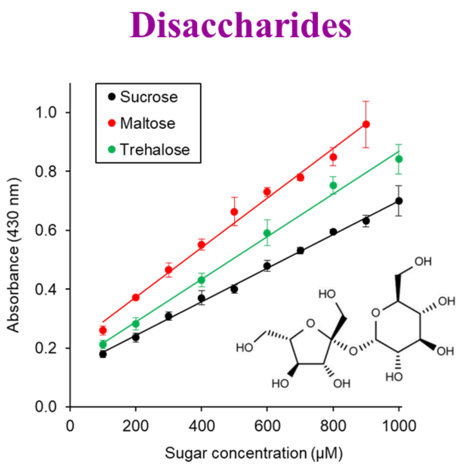
AgNPs Sugar

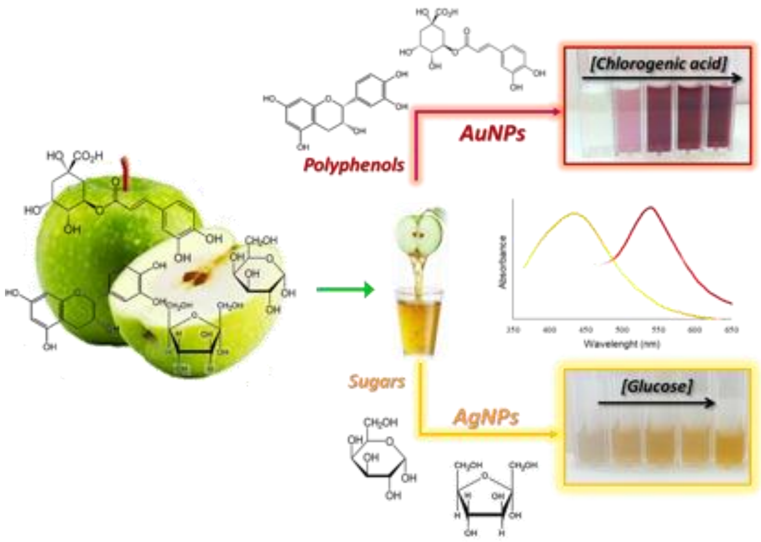
Sugar Content Evaluation

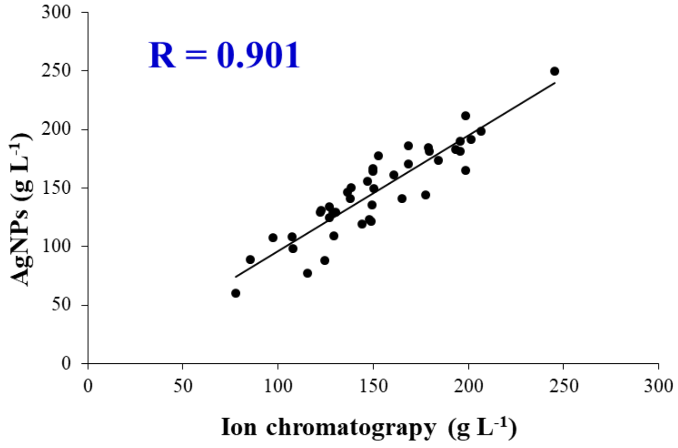












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Silver nanoparticles-based plasmonic assay for the determination of sugar content in food matrices

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Silver and gold nanoparticles based colorimetric assays for the determination of sugars and polyphenols in apples

Annalisa Scroccarello, Flavio Della Pelle, Lilia Neri, Paola Pittia, Dario Compagnone*

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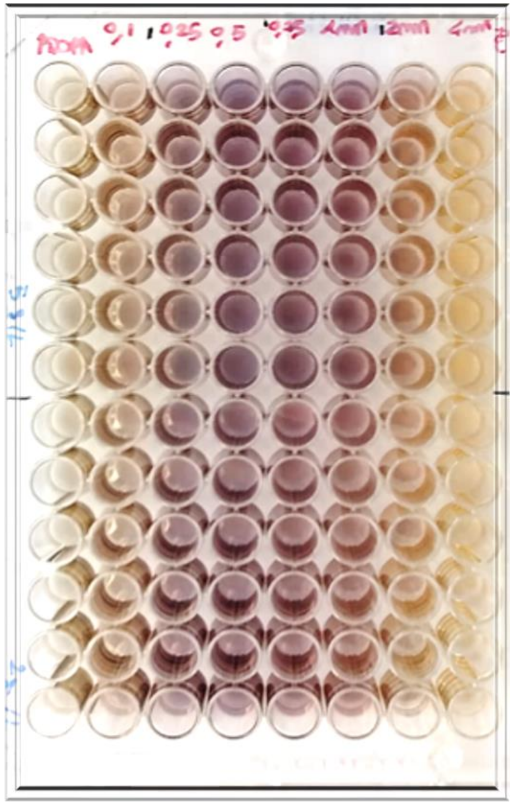
MNPs kit and devices realization

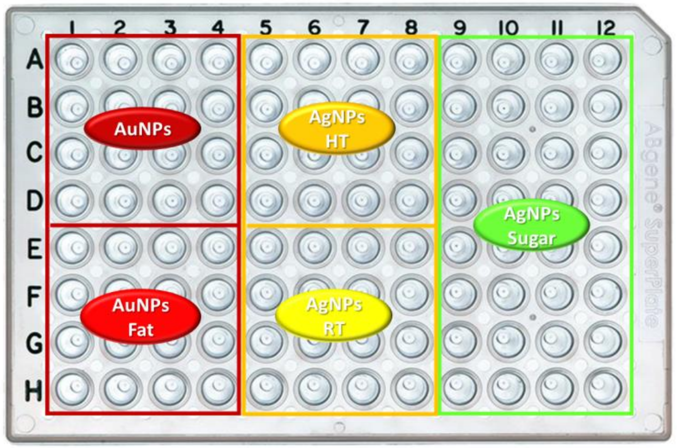
Future perspectives



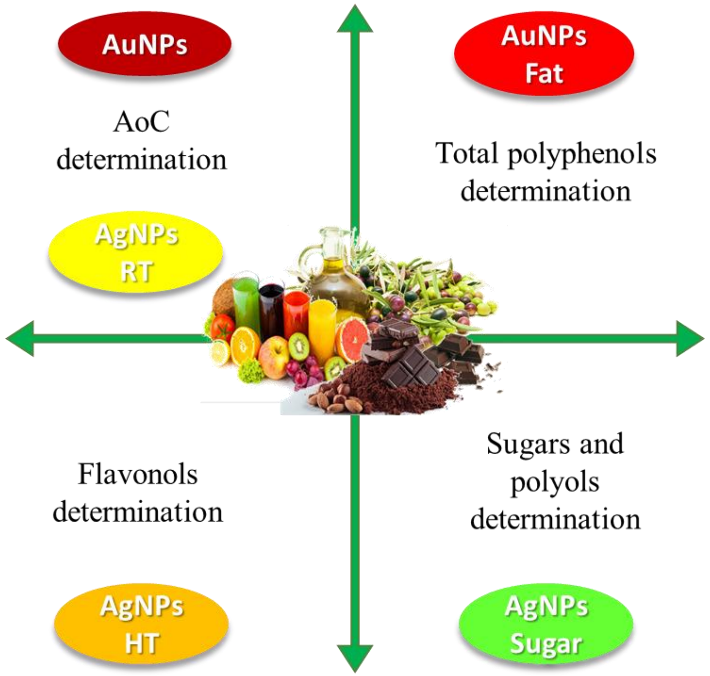
a)

Multi-MNPs kit devices for food fingerprinting

b)



… and others metal sources



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sensors

MDPI

Review

Nanomaterial-Based Sensing and Biosensing of Phenolic Compounds and Related Antioxidant Capacity in Food

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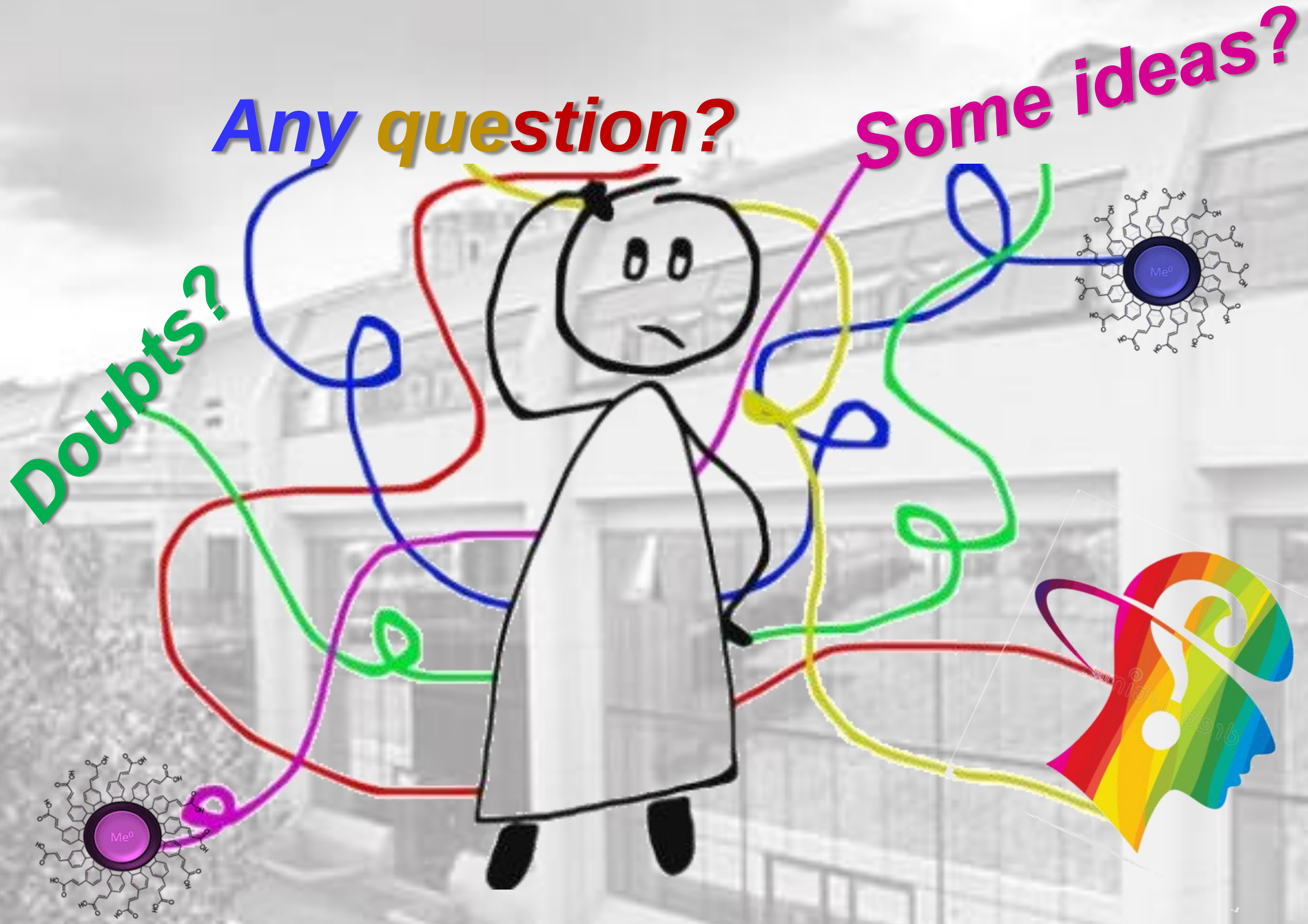

...Thanks for your attention...